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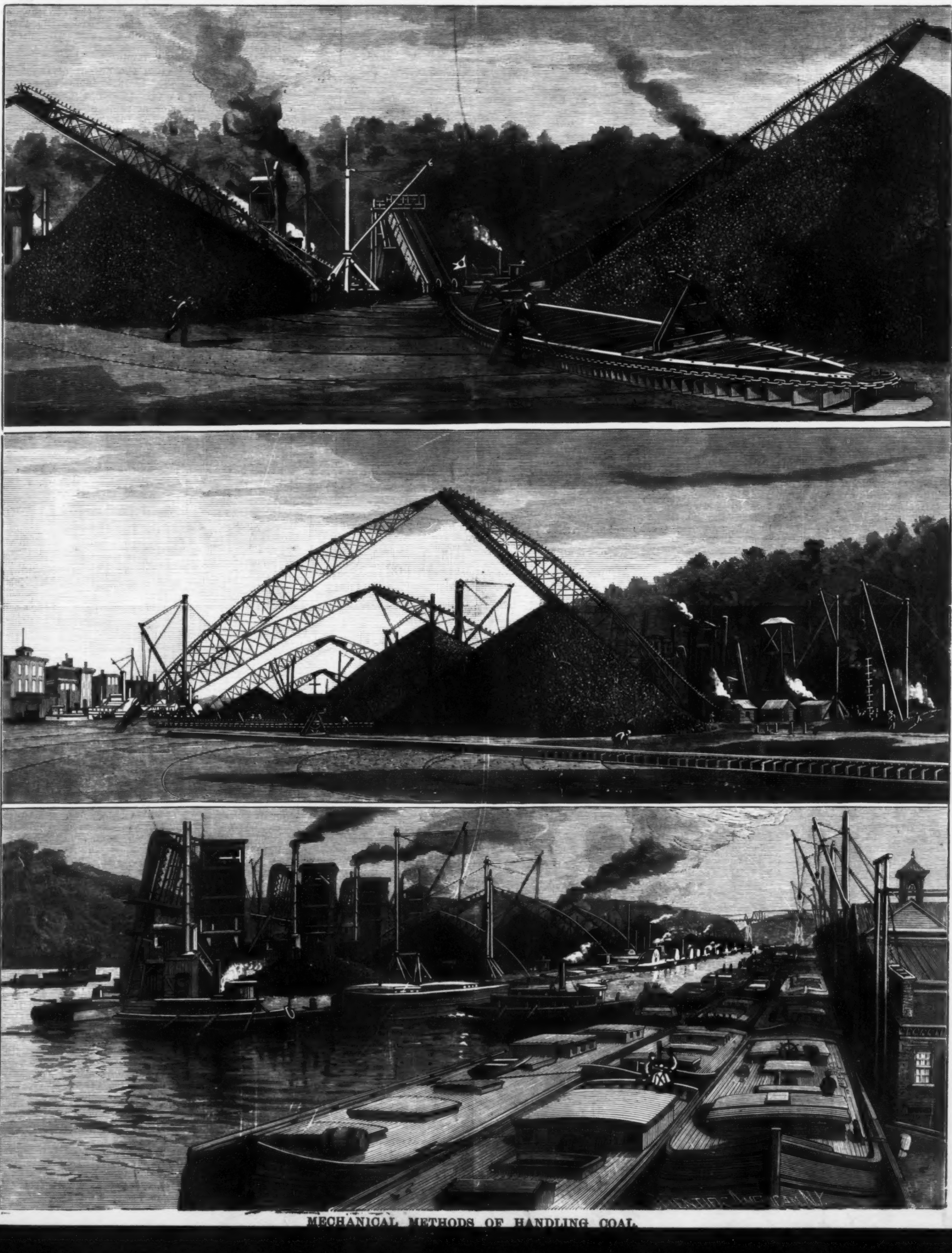


MECHANICAL METHODS OF HANDLING COAL.

DOCK EQUIPMENT FOR THE RAPID HANDLING OF COAL AND ORE ON THE GREAT AMERICAN LAKES.*

By ARTHUR C. JOHNSTON, Member Civil Engineers' Club of Cleveland.

SIR WILLIAM H. WHITE, director of naval construction in the British navy, in a recent review before the Institution of Mechanical Engineers, says: "One of the most marked tendencies in recent construction has been the increase in size and carrying power of ships. Unless there had been a corresponding development in the means of dealing with cargo this increase in size could hardly have occurred, and the advantages resulting from that increase would not have been realized." And further he says: "It is well recognized that unless there is 'quick dispatch' in loading and unloading cargoes very serious diminutions of earnings must result from the longer detention in port. Hence it follows that for the complete commercial success of the larger classes of cargo carriers lifting appliances of the most efficient character and of ample capacity are of the greatest importance." If this is true of ocean-going vessels, where voyages are, on the average, comparatively long and extended, to a much greater extent is it true of vessels carrying cargo on the Great Lakes, where, even with rapid loading and discharging of cargoes, the ratio of time spent in port to that spent in transit is very great, amounting to one-sixth under the most favorable circumstances. The object of this paper is to deal with the special types of machinery built for the purpose of insuring "quick dispatch" in loading and unloading the enormous tonnage of ore and coal that is shipped annually on the Great Lakes, the foundation of the gigantic steel industry that has made the United States a competitor in the markets of the world.

The shipments of ore from Lake Superior iron ranges represent roughly one-third of the entire freight traffic on the lakes, and for this reason a large fleet of modern cargo vessels has been built specially for this trade, represented as a type by the tow barge shown in Fig. 2, the steam barges being of the same general type. The largest of these are 500 feet long and 50-foot beam, the distinctive feature of these boats being the large size and number of hatches—30 to 34 feet long by 8 feet wide, spaced 24 feet center to center along the entire available deck length. This greatly facilitates loading and unloading operations, at the expense, however, of the strength of the deck plating, since the ship is almost cut in two crosswise of her deck.

In Fig. 3 is shown the cross-section of a typical ore-loading dock and the method of loading vessels. The ore is dropped into the pockets from drop-bottom "Jumbo" cars running on the tracks above, and from the pockets the chutes discharge the ore into the vessels lying alongside the dock. At the end of the season of 1898 there was, at the different points, a total of 4,354 pockets, having a total storage capacity of 623,612 gross tons of ore, constructed at a cost of about $7,000,000. The following table gives a list of docks, with principal dimensions and location, and the names of the railway companies owning them.

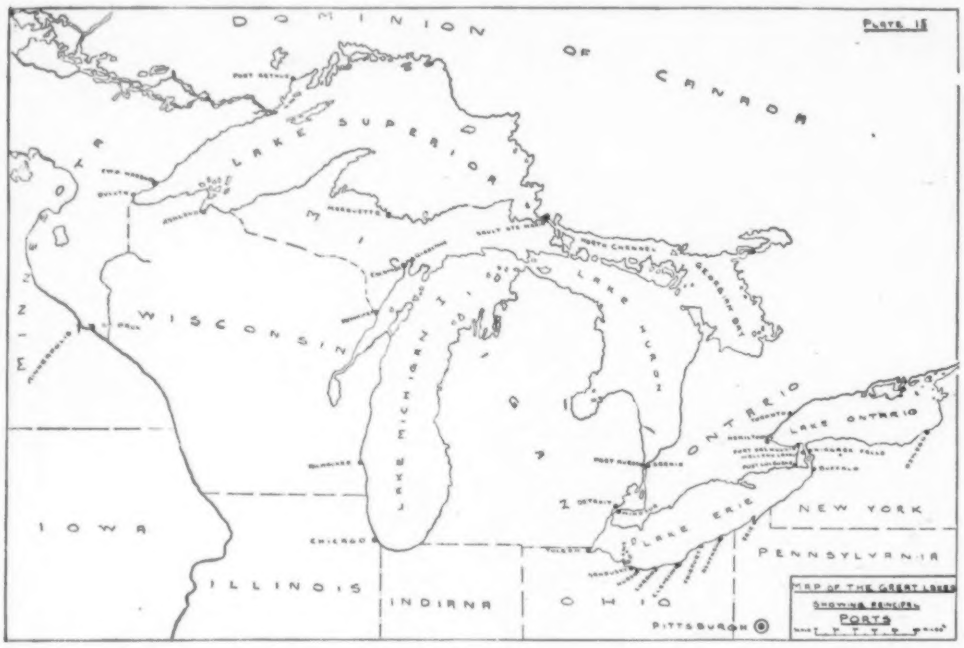


FIG. 1.

RAILWAY.	LOCATION.	Dock No.	Length of Dock in Feet.	Width of Dock.	Height of Dock Water to Deck.	No. of Pockets.	Storage Capacity. Gross Tons.
				Ft. In.	Ft. In.		
Duluth and Iron Range R. R. Co.	Two Harbors, Minn.	1	1,056	41 0	45 6	141	18,000
		2	1,248	......	57 0	208	41,600
		3	540	40 0	51 6	90	16,000
		4	1,008	49 0	51 6	168	30,000
		5	1,008	49 0	54 0	168	33,000
Duluth, Masaba and Northern	Duluth, Minn.	1	2,340	52 0	53 6	384	57,600
		2	1,738	52 0	57 4	288	42,400
Duluth, Superior and Western Ry.	Allouez Bay Superior, Minn.	1	a- 300	49 8	52 0	40	12,000
			b-1,200	49 8	57 0	190	25,500
Chicago and Northwestern R. R.	Ashland, Wis.	1	1,404	46 8	54 0	234	36,036
		2	1,404	46 0	58 8	234	24,156
	Escanaba, Mich.	1	1,404	37 0	46 0	184	24,104
		3	1,356	37 0	39 0	226	30,284
		4	1,500	37 0	39 2	250	37,500
		5	1,392	37 0	51 10	232	43,152
Duluth, South Shore and Atlantic R. R.	Marquette, Mich.	1	1,700	40 0	45 0	270	27,000
		3	1,200	53 6	37 0	213	12,780
		4	1,200	36 8	47 3	200	28,000
Lake Superior and Ishpeming	Marquette, Mich.	1	1,200	52 0	54 0	200	36,000
Minneapolis, St. Paul and Sault Ste. Marie R. R.	Gladstone, Mich.	1	768	37 0	47 0	120	15,000
Wisconsin Central Lines.	Ashland, Wis.	1	1,908	36 0	54 6	314	33,500

The Duluth, Masaba and Northern Railway has now under construction a new dock which is 66 feet 6 inches in height, 62 feet in width, the heel of the spout being 40 feet above the water line. There will be 192 pockets, with a capacity of 210 tons each. The additional width permits the placing of a track along the center of the dock for storing empty cars and minimizing the work of the switching engines. The dock proper will require 6,500,000 feet of sawed timber and 4,780 pieces of piling.

The pockets of these docks can be filled with the different grades of ore ready to be discharged into the vessels as they arrive, and it is not an uncommon thing for a vessel to come alongside of one of these docks, take on a cargo of 5,000 tons of ore and depart within two or three hours from the time it reached port. In the busy seasons, however, the vessels are loaded directly from the cars by dropping the ore through the pockets. Timbers are placed across the lower hatch to break the fall of the ore, and, with proper manipulation of the chutes, an entire cargo can be loaded with little or no trimming.

The following table gives the output of the Lake Superior ranges from 1895 to 1899, inclusive.

OUTPUT OF IRON ORE FROM ALL MINES OF THE LAKE SUPERIOR ORE REGION, 1895 TO 1899, INCLUSIVE.

PORTS.	1899	1898.	1897.	1896.	1895.
Escanaba	3,720,218	2,803,513	2,302,121	2,321,931	2,860,172
Marquette	2,733,596	2,245,965	1,945,519	1,564,813	1,079,485
Ashland	2,703,447	2,391,088	2,067,637	1,566,236	2,350,219
Two Harbors	3,973,733	2,693,246	2,651,465	1,813,992	2,118,156
Gladstone	381,457	335,955	341,014	220,887	109,211
Superior	878,942	550,403	531,825	167,245	117,884
Duluth	3,509,965	2,635,262	2,376,064	1,988,932	1,598,783
Total by lake	17,901,358	13,655,432	12,215,645	9,644,036	10,233,910
Total by rail		369,241	253,993	290,792	195,127
Total shipments	17,901,358	14,024,673	12,469,638	9,934,828	10,429,037

Practically all this ore is unloaded at South Chicago for consumption there, or at some of the Lake Erie ports for consumption in the Pittsburg district. The relative locations of these places will be seen on the map in Fig. 1. One of the most recent and largest installations of ore-unloading equipments is the plant on the docks of the Lorain Steel Company, built by the McMyler Manufacturing Company, and shown in Fig. 4. The plant consists of four machines of three bridges each, the distinctive feature being the long cantilever of 127 feet overhanging the boat and the great length of bridge. On a return trip from the bottom of the boat to the extreme end of the rear cantilever the bucket travels 940 feet. As will be seen, the ore can be dumped on the stock piles, or through the suspended hoppers into cars, which carry it to the furnaces situated directly behind the hoists. In Fig. 5 is shown the wagon and front stop used on these machines, and Fig. 6 is a detail of the 20-cubic-foot bucket used. The most economical size of bucket for use in connection with ore hoists has been found to be from 17 to 20 cubic feet capacity, as a larger bucket is so heavy for the shovelmen to handle that much time is lost. Seventeen cubic feet contain one gross ton of light soft ore or 2,500 pounds of hard ore. Each bridge of the conveyors shown in Fig. 4 is equipped with a pair of 12 by 12-inch non-reversing engines carrying a 40-inch drum directly on the crankshaft for the main hoisting rope. As will be seen from Fig. 5, the wagon is arranged with a "three-part" hoist, but in traveling along the bridge the full circumferential speed of the drum is effective on the wagon; so that a single revolution of the engine carries the wagon 10 feet 5 inches along the bridge in trolleying, or lifts the bucket 3 feet 5⅝ inches in hoisting, thus making the machines very quick in action. In returning the wagon the incline of the bridge is aided by a counterweight in the rear tower. The main hoisting ropes are ⅝ inch in diameter (½-inch ropes having been found too light for the severe service), running on 24-inch sheaves, except in the wagon, where they are 17 inches, and in the hanging block, where they are 14½ inches in diameter. The engines have auxiliary drums for hoisting the boom or apron that overhangs the boat, and they are also arranged to move the front end of the bridges in or out from the center bridge in order to accommodate any spacing of hatches and to propel the front tower along the track parallel to the dock face. The rear towers are moved by a locomotive on a parallel track. The returning wagon is controlled by a band brake on the drum, worked by the foot of the operator. These machines have made some remarkable records in point of speed, as an individual wagon has made fifty return trips per hour, carrying the bucket from the

FIG. 2.—TOW BARGE "MAGNA."

Gross tonnage, 3,359. Net tonnage, 3,124. Keel, 352 feet. Beam, 44 feet.

* From the Journal of the Association of Engineering Societies.

bottom of the boat to a point halfway between the towers. The best cargo record was 3,241 gross tons taken out in twelve and one-half hours by six bridges. The operator is located in the front tower in these machines, in full view of the hatch, which makes the matter of getting the bucket up and down through the hatch much easier and quicker than when he is further removed from the boat.

(To be continued.)

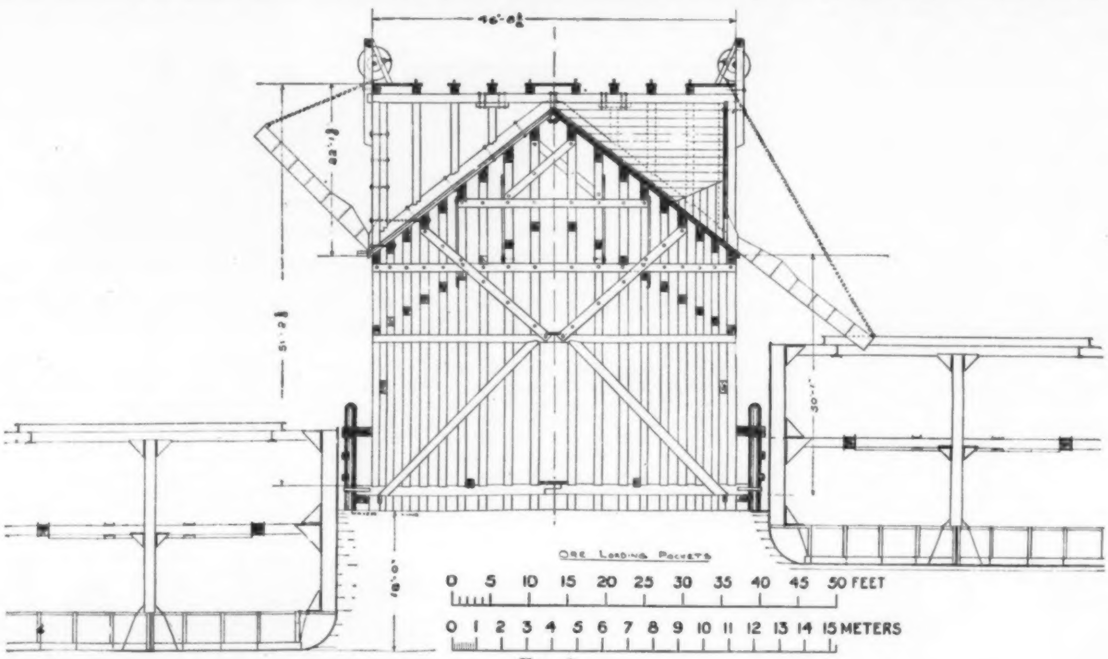


FIG. 3.

ELECTRICAL PRINTING PAPER PERFECTED BY ENGLISH PHOTOGRAPHER.

PRINTERS are said to be much interested in the work of an English photographer, a Mr. F. Greene, of London, who has met with considerable success in producing a paper by means of electricity which may be printed upon without employing inks or the use of any previous sensitizing matter by saturation, as has heretofore been done, says The Electrical Review.

Instead of saturating this "electrographic" paper with the sensitizing materials as has hitherto been done, it has been found best to mix them with the pulp in the process of manufacture, and so a radical departure has been made and a new machine-made paper has been invented that has rare properties. The chemicals used are abundant and cheap, so that this paper can be produced as cheaply as common paper. The prepared paper is stable and colorless, is unaffected by any other agent than the electric current; may be kept indefinitely and sent to the press directly from the roll as manufactured, with no preliminary treatment whatever; yields instantly a dense black permanent print, requires no subsequent fixing or developing; indeed, is ready for distribution immediately, as there is nothing like ink to smirch or require drying; briefly, it meets all the requirements of a perfect medium for electric printing. The machine for electric printing is simply an ordinary press divested of all its inking mechanism and having the cylinder or paper-bearing surface covered with a suitable conducting metal. The work of "make-ready" is the same as for ordinary printing, and line blocks, electrotypes, woodcuts, half-tones, engravings, all kinds of designs in relief may be used at will. The form is connected with one pole of the dynamo or battery—for most purposes the current may be taken from an ordinary incandescent light wire—the paper-carrying cylinder or surface is connected with the other pole. Thus the metal surfaces of both cylinders are the electrodes, while the paper is in reality a very thin cell in which the pulp is an inert medium and the contained chemicals the electrolyte which is to be subjected to electrolysis. As the cylinders approach each other to press the paper as it is fed between them, the current is switched on automatically and flows from one cylinder through the paper at the points of contact to the other cylinder, the impression being produced instantly by electrochemical action. The paper possesses conducting properties, so that the voltage used may be from 10 to 110 volts, and four amperes for the largest machines. All inking mechanism being dispensed with, the power required to drive the press is much less. For a given piece of work, the cost of current for the actual printing is said to be only one-half that of ink, while at least a saving of one-third in the cost of presses is assured. The new process lends itself readily to all speeds, even to the fastest web presses. At an exhibition at Blackpool, England, witnessed by a large company of printers and scientists, a rotary press was run at the rate of six thousand impressions per hour, and the work was declared perfect in every particular. Relative to the appearance of electric printing, The Journal of Printing and Kindred Industries of the British Empire says it greatly resembles lithographic work. It is reported that several of the great London dailies have placed their plants at the disposal of the invention for an exhaustive test of the process.

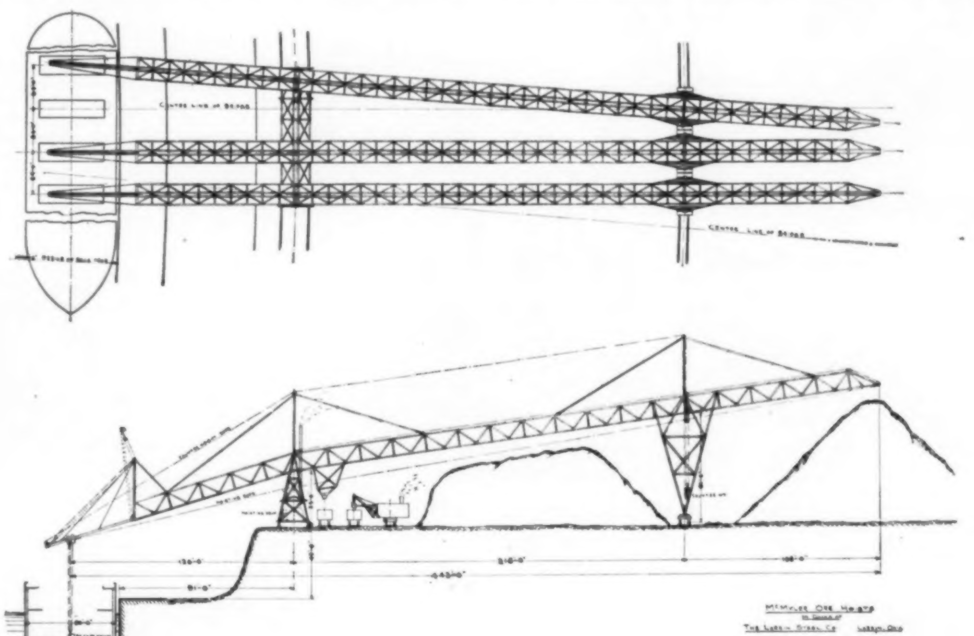


FIG. 4.

NATURAL gas in the United States, according to the last annual report of the United States Geological Survey, has sunk to about one-third, in its fuel value, of what it was a few years ago, says Cassier's Magazine. In 1899 the production of natural gas equaled in consumption the heating capacity of 5,400,000 tons of coal. Ten years ago, when this industry was at its height, the equivalent of the heating output of natural gas was equal to about 15,000,000 tons of coal. Both the great gas-producing fields are reaching extinction. The Ohio division, which once had 480 pounds to the square inch, has now no rock pressure whatever. The original rock pressure in Indiana, once 325 pounds, averages now 165 pounds, showing that two-thirds of the product has been taken out and consumed. Over a very considerable area of Indiana, covering an area

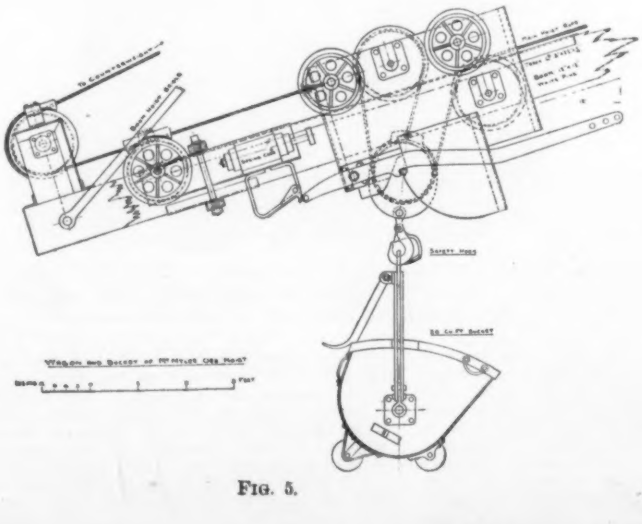
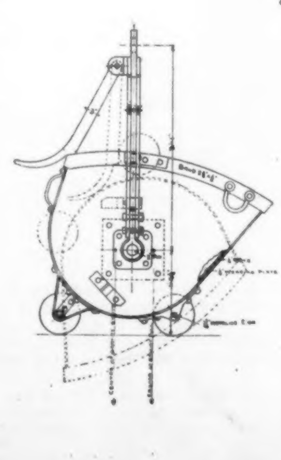


FIG. 5.



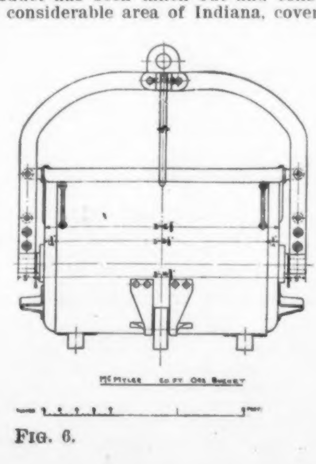


FIG. 6.

of about 1,500 square miles, industries which were using natural gas are either discontinued, working at a disadvantage, or substituting coal. The effect of this is plain in various directions, particularly in reduced business and opportunities for labor in part of the State. The aggregate value of the gas produced in 1899 was $20,024,864, a gain of $4,730,051 over 1898. This is in part due to a slight increase in the cost, but still more to an increased demand.

FOREIGN LOCOMOTIVES AT THE EXPOSITION OF 1900.

Among the nations that sent locomotives to the Vincennes annex, Germany stood foremost as regards the number and size of the engines exhibited. We shall examine such of the locomotives as more particularly struck us by their arrangements, and, in doing so, shall present a few data concerning the works at which they were constructed, so as to give an idea of the great development taken by the metallurgic industry and mechanical construction in Germany since the year 1870.

SAXONY.

Anciens Etablissements Richard Hartmann, Société Anonyme at Chemnitz.—The Société of Chemnitz exhibited three compound locomotives, viz.: (1) a compound express locomotive designed for the Saxony State Railways; (2) a compound passenger locomotive for the Norwegian State Railways, and (3) a petroleum tender locomotive for the Netherland-Indian Railway Company, Java. Before entering into the details of these three interesting engines, it will prove instructive to take a glance at the increase of the works in which they were studied and built.

In 1837, an Alsatian, Richard Hartmann, of Bar (Haut-Rhin), established himself at Chemnitz (Saxony) with three workmen. In 1870, thirty-three years later, the rudimentary shop had become an establishment employing 3,000 operatives. At this date, the works passed into the hands of the present Société Anonyme. At present, the works employ 5,200 men, and cover about fifty acres of land at Chemnitz and 146 acres in one of the faubourgs of that city. The establishment owns 2,400 machine tools, 21 power hammers, 2 central power and electric light installations, 116 buildings and 22 blast furnaces. The capital stock for 1900 is 15,000,000 francs. Up to this date the works have built 2,600 locomotives, 829 tenders, 1,875 steam engines of various systems, 3,300 boilers and 293 steam hammers, of a value of 351,250,000 francs.

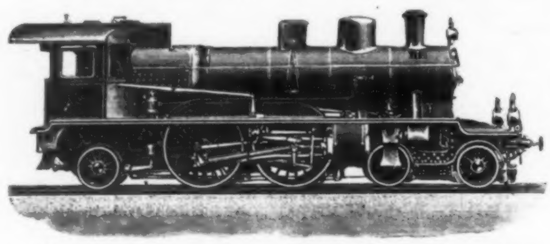


Fig. 1.—FOUR-CYLINDER COMPOUND EXPRESS LOCOMOTIVE FOR THE STATE RAILWAYS OF SAXONY.

Let us now return to the locomotives exhibited.

(1) Compound Express Engine for the Saxon State (Fig. 1).—This engine is designed for hauling the imperial train in its heaviest state of composition; that is to say, 385 tons (locomotive and tender not included), without stoppage, from Dresden to Leipzig, at a mean speed of 60 miles an hour. The profile of the line includes gradients of 1-200 and 1-180, and curves of a mean radius of 900 feet.

The distance from Dresden to Leipzig is 69 miles. The engine is constructed with a view to attaining the highest speeds when the load is less than that mentioned above. Being given the great weight of the engine and boiler and the admitted maximum of 16 tons per axle, the problem was solved in an engine with a movable 2-axle fore carriage, 4 cylinders and 2 coupled axles, and a radial bearing axle behind. The tender, on the contrary, has 4 axles in two movable carriages. The engine is of about 1,300 horse power, and the boiler produces 19 pounds of steam to the square foot of heating surface. The boiler, external firebox, dome and smoke box are of Siemens-Martin steel plate from the Krupp-Essen Works. The thickness of the plates of the fire box is 0.6 and 0.7 of an inch and that of the tube plate 1.12 inch. According to the prescriptions of the State railways of Saxony, the front section of the cylindrical body of the boiler is provided with a narrow iron plate ring which, in case of a corrosion of the tube plate, can be easily replaced without the necessity of removing any of the long sections that compose the telescopic boiler. The body of the boiler contains 228 soft steel seamless tubes 1.8 inch in diameter and 15.5 feet in length. The boiler has 6 large and 8 small cleaning-doors. The whole boiler is protected against external radiation by sheets of felt and an iron plate jacket. The frame, which is composed of two principal sole bars of soft steel 36 feet in length, rests upon a movable fore carriage with two axles and a brake, two coupled driving axles and a radial bearing axle in the rear. The pivot of the movable fore carriage is of steel with a hemisphere of copper and rests in a support of cast steel. The fore carriage permits of a play of 1.6 inch on each side, and the radial hind axle of a play of 0.8 of an inch. The engine, which is a compound one, has four cylinders and a starting gear of the Lindner system. The high pressure cylinders are 14 inches in diameter, with a piston stroke of 26 inches, and are placed on the outside. The two low-pressure cylinders are 22 inches in diameter, with a piston stroke of 26 inches, and are on the inside of the sole bars. The distribution of the high pressure cylinders is of the Heusinger system, and that of the low pressure ones of the Joy system. All the slide valves are balanced and of cast iron, as are the compensators. The parts of the distribution are of Siemens-Martin soft steel. The slides, which are of the Heusinger system, are of tempered and cemented iron, and those of the Joy distribution are of phosphor bronze. The cylinders are surrounded with cork and wood. The pistons are of Krupp Annen cast steel and the rods of ordinary cast steel. The cranks of the inside cylinders are keyed at 90 degrees. The angle of the outside cranks is 180 degrees.

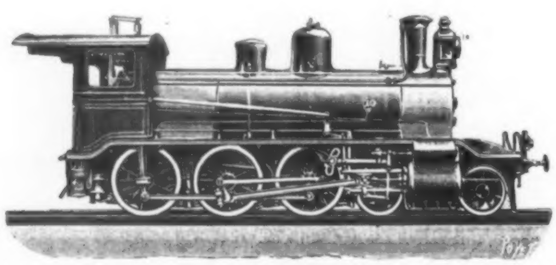


Fig. 2.—COMPOUND PASSENGER LOCOMOTIVE FOR THE STATE RAILWAYS OF NORWAY.

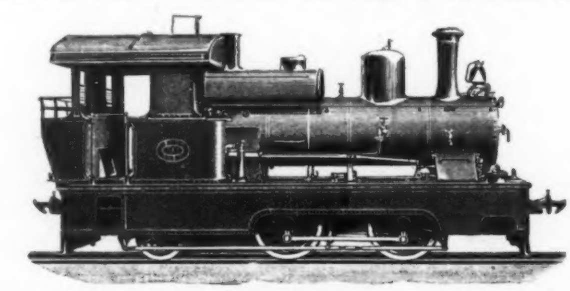


Fig. 3.—COMPOUND, PETROLEUM-FIRED TENDER-LOCOMOTIVE FOR THE NETHERLAND-INDIAN RAILWAY.

The brake is of the Westinghouse system and acts not only upon the coupled wheels, but also upon the wheels of the front bogie. The maximum stress of the brake is, in the bogie, 62 per cent of the load, and, in the coupled wheels, 50 per cent. Finally, the weight of the engine, empty, is 132,660 pounds, and, in service, 145,900. In the tender, such weights are respectively 43,824 and 93,325 pounds.

The length of the locomotive and tender between buffers is 84 feet.

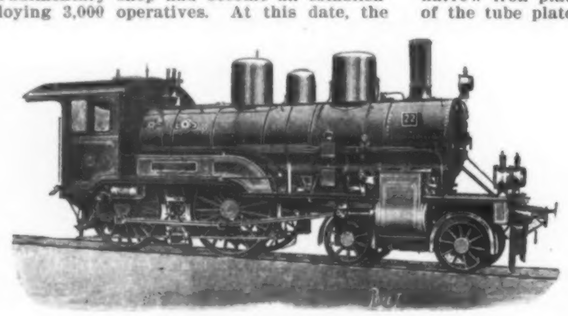


Fig. 4.—LOCOMOTIVE OF HANOVER.

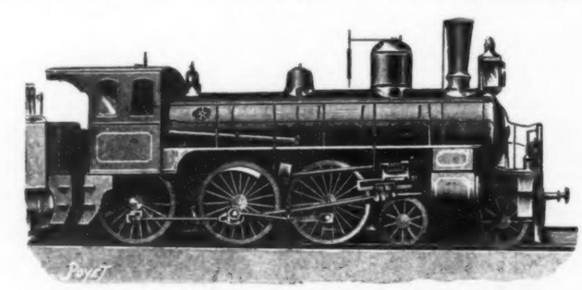


Fig. 5.—RUSSIAN LOCOMOTIVE.

(2) Compound Passenger Locomotive for the Norwegian State Railway (Fig. 2).—This locomotive, constructed for hauling not only passenger trains, but also mixed trains over a particularly broken profile presenting gradients of from 17 to 20 to 1,000, for a total length of 75 miles, plus 48 miles in curves of which 16 per cent have a radius of 835 feet, has to present a great tractive power and perfect stability. The principal features are as follows: Six coupled wheels; maximum load on the axles, 36,400 pounds; bogie with four wheels in front; diameter of the coupled wheels, 7.5 feet; diameter of the bogie wheels, 40 inches; boiler pressure, 13 atmospheres.

The boiler, as well as the fire box, dome and smoke box, are of Siemens-Martin soft steel. The telescopic

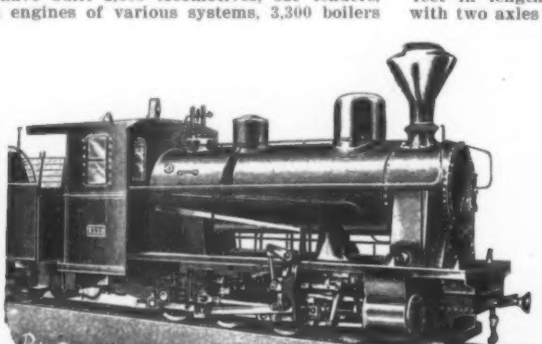


Fig. 6.—RUSSIAN LOCOMOTIVE.

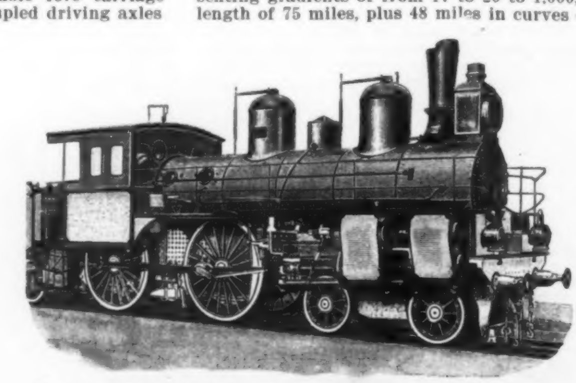


Fig. 7.—HIGH-SPEED LOCOMOTIVE OF THE COMPOUND-TANDEM SYSTEM FOR THE SAINT PETERSBURG-WARSAW RAILWAY.

body of the boiler is of plate 0.6 of an inch in thickness. The plate of the fire box is 0.64 inch in thickness. The furnace is of 0.64 inch copper, save the tube plate portion, which is 1 inch. The boiler contains 210 charcoal iron tubes 1 inch in diameter and 13 feet in length. The grate, the bars of which are of forged iron, has a vault of refractory bricks above it.

The frame consists of two soft steel sole bars strengthened by long horizontal and vertical cross-stays. It rests in front upon a 2-axle bogie through the intermedium of a cylindrical pivot, and behind upon 3 coupled axles, the center one of which is the motor axle. The axles, as well as the tires, are of crucible steel. The centers of the wheels, the grease boxes, the slides and the axle-guards are of homogeneous cast iron. The diameter of the high pressure cylinder is 18 inches and that of the low pressure one 26. The piston stroke of both cylinders is 26 inches. The distribution is of the Heusinger system. The slide valves are of crucible cast iron. The cylinder covers are provided with safety valves. The pistons, piston-heads and slide supports are of Krupp-Annen cast steel. In addition to an automatic brake, of the Hardy Brothers system, there is a hand brake. The sand box is of the Gresham type.

The tender holds 2,900 gallons of water and 3.5 tons of coal. All the wheels may be acted upon on one side by hand through a screw brake or a vacuum brake. The tender is provided in the rear with a tool chest of large size and in front with two small ones protected against snow storms by a movable wall. The locomotive weighs 30,200 pounds empty and 101,200 in service. The corresponding weights of the tender are 31,746 and 63,800 pounds. The locomotive and its tender, from buffer to buffer, are 51 feet in length.

(3) Petroleum Tender-Locomotive for the Netherland-Indian Railway Company, Java (Fig. 3).—The programme prescribed for the construction of this engine by the Netherland-Indian Railway Company included some very peculiar desiderata. In the first place, the track to be traveled over was of 3.28-foot gage with gradients of 1-200 and curves of a minimum radius of 490 feet. On another hand, it was necessary to protect the motive parts and the distribution against dust without rendering the inspection of such parts difficult. Finally, the locomotive had to haul 140 tons of effective weight at a speed of 15 miles an hour, or at a speed capable of reaching 24 miles on a level. The greatest load admissible per axle was 18,480 pounds.

The body of the boiler, composed of two telescopic sections, is of Siemens-Martin steel plate 0.4 inch in thickness. The internal fire box is of copper. In the body of the boiler are arranged 120 seamless tubes 1.4 inch in diameter and 8.25 feet in length. The heating by petroleum is done by the Holden system. The petroleum reservoir, of 1,140 pounds capacity, is heated by two worms and is situated above the cylindrical body of the boiler. The petroleum residua are thus kept as liquid as possible. In order that the petroleum may not catch fire on hot days, there are arranged two grille slide-valves that allow of access of air to cool the petroleum. The jet of petroleum is thrown under an arch against a wall arranged for the purpose.

The engine, which is compound, has two internal cylinders cast integrally. They are respectively 11 and 16 inches in diameter, and their pistons have a stroke of 16 inches. The distribution is of the Heusinger system. The slide valves are of phosphor bronze. The weight of the engine, empty, is 42,856 pounds, and, in running order, 55,352.

HANOVER.

The Hanover locomotive (Fig. 4) for fast trains, with double expansion, 4 cylinders, and 4 axles (two of which are coupled), was constructed at the works of the Société Hanoverienne de Constructions Mecaniques, at Linden-les-Hanover. The interesting features about it are that the two high-pressure cylinders and the two low pressure ones act upon the same driving axle, and that, too, in the following manner, viz., the high pressure cylinders upon the cranks of the axle and the low pressure ones upon the crank pins of the driving wheels. It is well, too, to point out the fact that there are two distributors that do duty for the 4 cylinders. This peculiarity simplifies and greatly facilitates the surveillance and maintenance.

On each side of the engine there is a high pressure and low-pressure cylinder which, with the valve box, form a single piece. The two pairs of cylinders are assembled in the axis of the engine. The diameters of the cylinders are respectively 14 and 20 inches, and the stroke of the pistons is 24 inches. The diameter of the driving wheels is 6.5 feet and that of the other wheels 3.28 feet. The pressure is 14 atmospheres. The grate surface is 24.5 square feet and the total heating surface 1,327.5 square feet. The weight of the engine, empty, is 18.6 tons, and, under a load, 52.75 tons; and, with the tender in service, 86 tons. The brake is of the Westinghouse system.

This locomotive has hauled a load of 300 tons over a level and straight track at a speed of 54 miles an hour.

BAVARIA.

The Société Krauss et Cie., of Munich, sent to Vincennes four locomotives, one of which was exhibited in the Austrian section. (1) An express locomotive with six axles (two of them coupled) and an auxiliary driving axle; (2) a passenger tender-locomotive with 5 axles (two of them coupled); (3) a tender-locomotive, for a narrow track, with 2 coupled axles, and (4) a tender-locomotive with 4 axles (3 of them coupled) for a track of 30-inch gage.

Before closing this succinct resumé of the German exhibit, it is well to call the attention of our readers to a few very suggestive figures. The first railway line constructed in Germany was that between Nuremberg and Furth, and which was inaugurated in 1837.

The total length of the railways under exploitation in Germany was:

In 1870	11,816 miles.
In 1880	20,300 miles.
In 1890	25,874 miles.
In 1900	30,410 miles.

Of these 30,410 miles, 29,100 miles have tracks of a normal gage, and 1,310 miles tracks of narrow gage.

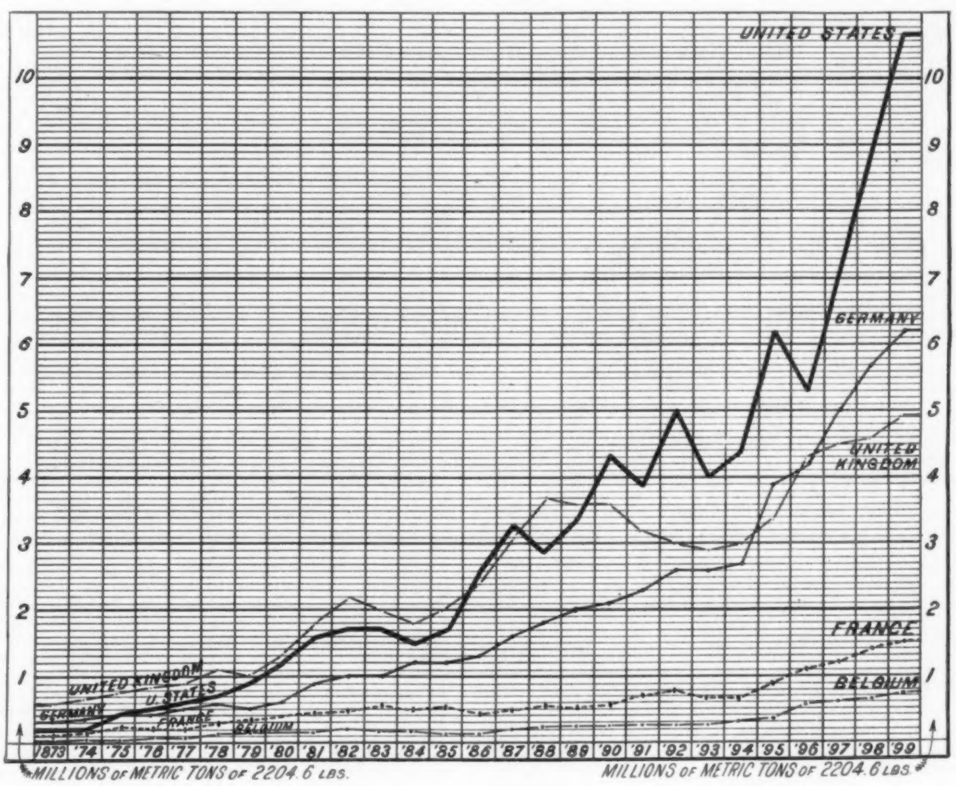
On another hand, in 1870, the exploitation embraced 4,414 locomotives, and in 1900 18,752. The total number of locomotives imported from foreign countries has been 419 only; and such importation occurred at an epoch at which there were as yet no locomotive works in Germany. It is pretty well known that it is quite otherwise at present, and the above figures speak with sufficient eloquence to make it useless to comment upon them.

RUSSIA.

Société des Usines de-Kolomna (Government of Moscow).—These works, founded in 1862 by captain of engineers, Amand de Strouvé, employ at present fifteen thousand workmen. Their exhibit at Vincennes embraced two locomotives, one of them for passenger and the other for freight trains.

The former of these (Fig. 5), of the compound system with 3 coupled axles, is heated by naphtha. The distribution of steam is of the Heisinger von Waldegg system. It is capable of attaining a speed of 48 miles an hour. The principal dimensions, etc., are as follows:

Diameter of driving wheels	6 feet.
Diameter of front wheels	3.38 feet.
Diameter of high pressure cylinder	20 inches.
Diameter of low pressure cylinder	30 inches.
Stroke of piston	26 inches.
Number of tubes	192
Total heating surface	1,635 sq. ft.
Weight of engine, empty	57 tons.
Weight of engine, under load	63 tons.
Steam pressure	11.5 atmos.



PRODUCTION OF STEEL BY PRINCIPAL COUNTRIES FROM 1873 TO 1899.

The freight locomotive (Fig. 6), which was built for a track of 30-inch gage, is heated with coal. The distribution of steam is that of von Waldegg. The diameter of the wheels is 30 inches, and the pressure of the steam is 12 atmospheres. The diameter of the cylinder is 14 inches and the stroke of the piston 12. The total heating surface is 590 square feet, and the locomotive, fully loaded, weighs 21 tons.

The Moscow-Kazan Railway Company's 6-axled Freight Engine.—This locomotive, built in 1899 at the Brunswick Works, is designed to perform service for long distance freight trains upon the Rousaicwka-Riason section (240 miles). It has to haul a weight of 1,140 tons over a profile having maximum gradients of 1-10 of an inch to the foot at a maximum speed of 25 miles an hour. It is heated with naphtha.

This compound duplex locomotive with 2 high pressure cylinders of 19 inches in diameter and 2 low pressure ones of 28, comprises the following dimensions, etc.:

Stroke of pistons	24 inches.
Diameter of wheels	48 inches.
Interior diameter of boiler	53 inches.
Number of tubes	234
Total heating surface	2,160 sq. ft.
Grate surface	26 sq. ft.
Weight of engine, empty	166,650 pounds.
Weight of engine, ready for service	179,300 pounds.
Weight of tender, empty	51,590 pounds.
Weight of tender, full	102,388 pounds.

The brake, which is of the Westinghouse system, acts upon 4 axles.

One peculiarity worthy of remark is the application of a metallic cable to the tender. The object of this is to haul the first 10 or 15 cars of the train therewith, while on the rest of the cars are used ordinary couplers, the resistance of which would be inadequate to haul the 60 fully loaded cars of which the train is composed.

The Saint Petersburg-Warsaw Railway's High Speed Locomotive (Fig. 7).—This engine, which is of the compound tandem type, was built at the Poutiloff Works of Saint Petersburg. It is designed for hauling express trains from Saint Petersburg to Warsaw, and has to attain a mean speed of 36 miles an hour with a load of 250 tons. Upon some portions of the profile, the speed reaches 60 miles. The first engine of this type was constructed in 1898, and was put in service upon the Saint Petersburg-Warsaw line during this same year. At the time of the first experiment with it, this locomotive hauled a 250-ton train for the distance of 145.8 miles that separates Saint Petersburg from Pskow, at a mean speed of 44.6 miles an hour. In this trip over a long gradient of 0.002 of an inch to the foot, it even reached a speed of 43.25 miles, and upon a down grade of 0.002 its speed was 65.8 miles.

The line under consideration has at present 49 of these locomotives in service.

The pressure of the boiler is 13 atmospheres, and the total heating surface is 1,570 square feet. The number of tubes, which are of iron, is 216. The grate surface is 28 square feet. The ratio of the heating surface to the grate surface is 55.8 : 1. The engine is provided with 2 high and 2 low pressure cylinders, the respective diameters of which are 14.6 and 21.8 inches. The stroke of the pistons is 25 inches. The distribution is of the von Waldegg system. The diameter of the coupled wheels is 6.56 feet, and that of the bogie wheels 3.28. The engine and tender are provided with the Westinghouse brake. The weight of the locomotive, empty, is 51.5 tons, and, under a load, 56.5. That of the tender, empty, is 16 tons, and, in running order, 35. The feed apparatus are injectors of the Friedmann system.—For the above particulars and the engravings, we are indebted to La Nature.

THE WORLD'S PIG IRON AND STEEL AND AMERICA'S SUPREMACY.

It is interesting to note the enormous growth of pig iron production during the nineteenth century, says Sell's Commercial Intelligence. Here are the figures, which are, of course, approximations:

THE WORLD'S PRODUCTION OF PIG IRON.

	Tons.
1800	825,000
1830	1,825,000
1850	4,750,000
1870	11,900,000
1880	17,950,000
1890	27,157,000
1899	39,410,000

We may now appropriately give the production of pig iron and steel in all countries in 1899, or in the most recent year for which statistics have been received. English tons of 2,240 pounds are used for Great Britain, Canada, the United States, and "other countries," and metric tons of 2,204 pounds for all other countries, metric tons being used as the equivalent of English tons in ascertaining the total production for all countries. The statistics of steel production for the United States, Great Britain, France, Belgium, Austria-Hungary, Russia and Finland, Sweden, Spain, and Canada embrace ingots and direct castings, but for Germany and Luxemburg and Italy complete ingot statistics are not available, and the statistics for finished steel have been used;

Country.	Pig Iron.			Steel.		
	Years	Tons.	Percentage.	Years	Tons.	Percentage.
United States	1899	13,620,703	34.56	1899	10,639,857	39.25
Great Britain	1899	9,305,319	23.61	1899	5,000,000	18.44
Germany	1899	8,142,017	20.66	1899	6,290,434	23.20
France	1899	2,567,388	6 51	1899	1,554,854	5.73
Belgium	1899	1,036,1·5	2 63	1899	729,920	2.70
Austria-Hungary	1898	1,427,240	3 62	1898	880,696	3.25
Russia & Finland	1898	2,222,469	5 64	1898	1,494,000	5.51
Sweden	1898	531,766	1 35	1898	265,121	.98
Spain	1899	295,840	.75	1899	122,954	.45
Italy	1897	8,393	.02	1898	94,667	.35
Canada	1899	94,077	.24	1899	22,000	.08
Japan	1897	57,678	.15	—	—	—
Other Countries (about)	1899	100,925	.26	1899	15,997	.06
Total		39,410,000	100.00	—	27,110,000	100 00

This table shows that nearly 70 per cent of the world's pig iron production is now made into steel, leaving only a little more than 20 per cent to be made into the various forms and kinds of iron. And yet Bessemer's first patent was granted as recently as February 12, 1856, and in the same year Siemens Brothers obtained the.r first p.tent for the use of the regenerative gas furnace in the open-hearth process of steel manufacture.

Different countries, it will be seen, make very different proportions of iron and steel. France produces only twice as much steel as iron. Germany, on the other hand, makes five times as much steel as iron. In the above table the relation of pig iron production to steel production is shown, and it will be noticed that the United States converts a larger percentage of her pig iron into steel than any other country.

We give this week a diagram showing graphically the production of steel in principal countries from 1873 to 1899, which should be compared with the diagram relating to pig iron production in the same countries which we published on the 17th ult. This diagram is the work of the Washington Treasury Bureau of Statistics, and is based upon the most reliable figures.

SOME LINKS BETWEEN NATURAL HISTORY AND MEDICINE.*

By J. ARTHUR THOMSON, M.A., F.R.S.E., Professor of Natural History in the University of Aberdeen.

LET me thank you, first of all, for your kindness in giving me this opportunity of addressing you, which I can assure you I regard as a pleasure and an honor. As my work does not lie exactly alongside of yours, I thought we might find a convenient line of contact by considering for a little some of the links between natural history and medicine. But as the day has already doubtless been long to some of you, as to me, we may perhaps consult our mutual convenience by trying to observe the virtue of brevity, and be content with illustrations of a subject which obviously affords material for prolonged discourse. The links between natural history and medicine which I wish to-night to illustrate are many and varied. Some were forged centuries ago, and some of these have since snapped; others are strictly modern; others, such as the role of mosquitos in spreading malaria, are at this moment in process of being formed and tested.

THE LEECH.

One cannot think of links between natural history and medicine without recalling, first of all, that a familiar animal—the leech—was used for so long (since before the Christian era) and so much (for all manner of ailments), that its name, which is said to mean "heal," became that of the medical practitioner himself. For people used to say, "Send for the leech," when we should say, "Send for the doctor," and leeching was synonymous with medical treatment. Yet, as everyone knows, a reaction set in; the leech—the animal, I mean—and bloodletting went out of vogue; leechponds disappeared; and I suppose the trade in leeches is now relatively trivial. There is a record of a Breton peasant, in 1883, who had received from the surgeon half a dozen leeches to apply to some congested or inflamed part. Being ignorant of the method of application, he handed over the problem to his wife, who in this case was wrong, for, on a neighbor's advice, she fried the leeches and gave them to the poor man. In spite of their bitter taste, he managed to get outside of them all, and died thereafter.

It is evident that the gentle art of using the leech is decadent. In The British Medical Journal for March 18, 1898 (I quote on the authority of Dr. Fernie), it is stated that "leeches, on which the older physicians placed such reliance, seem to be coming again into fashion." But we have known the ordering of a few leeches in a leading London hospital, not so many years ago, cause consternation among the dressers; a consultation had to be held as to which was the "business end" of the leech, and the combined intelligence of the staff was brought to bear on the problem "how to make him bite."

In former days, not very remote, a thoroughly qualified medical man was expected to have a knowledge of natural history, developed along a line which is now but rarely followed. He was expected to know a large number of forms, not because of their scientific interest, but because of their supposed practical value. In other words, he had to know the "animal simples," the uses of animals as medicines, uses which sometimes suggest gross superstition, but sometimes extraordinary insight. If we consult a compendium of animal simples, such as one by Dr. Fernie, we get two opposite impressions. We are amazed, on the one hand, at the credulity which is implied both in those who prescribed and in those who swallowed many of the reputed medicines. We wonder, on the other hand, at the justification which modern science has given to some of the old prescriptions.

* Address to the North British Branch of the Pharmaceutical Society. Reprinted from Pharmaceutical Journal.

It seems to me that we may divide the old prescriptions into three sets—those with no justification, perhaps 75 per cent; those with an obvious justification, perhaps 20 per cent; and those which have found some justification—by no means obvious—as the result of recent scientific progress, these forming the remaining five per cent.

OLD PRESCRIPTIONS.

The first set of old prescriptions, which I select from Fernie's "Animal Simples," includes those which have no real justification: Rheumatic patients were told to take a black cat to bed with them, for it is rich in curative electricity; the dust of a dried magpie was used in Germany as recently as 1880 as a cure for epilepsy; the skink lizard once held a place in British pharmacopœias as a cure for leprosy and much else; to stop hemorrhage the patient was recommended to lay hold of a dead toad, "horror and fright constraining the blood to run into its proper place for fear of a beast so contrary to humane nature"; to lay an open pickled herring on the soles of the feet on going to bed was deemed a cure for swollen legs—to thrifty Scots it would seem sheer wastefulness; we would prefer an internal application. These are a few of the least extravagant of the many old prescriptions which may, I suppose, be dismissed as without any justification.

The second class of ancient prescriptions includes those which may have something in them, for the obvious reason that the animals used contain certain potent or at least useful chemical substances. It is not surprising that decoctions of ants should have been found to have at least some effect, for ants contain formic acid; it is not surprising that powdered pearls—a dose for the wealthy—might be of some service, since pearls are made of lime; it is not surprising that the snail in its chemical complexity might have dietetic value. Has it not been called "the poor man's oyster"?

TOADS AND SNAKES.

Now, we cannot have much interest either in the grotesque prescriptions or in those whose justification is obvious, but there is a third set whose character affords food for reflection. I refer to those in which there lurks an undeniable kernel of truth—reached we can hardly tell how—which has been justified scientifically by modern researches. It has been shown that what seemed absurd (or worse) had sometimes a real justification. Two examples must suffice. Preparations of the toad were prescribed for such maladies as dropsy, and we now know that phrynin, the active principle in the toad's skin secretions, has a powerful influence on the pulsations of the heart; is very like the digitalin from the foxglove, and thus might really have a good effect in cases of dropsy from heart affections. As Dr. Hewlett points out in Science Progress, dried toads and toad ash, and toads in other forms, have been used medicinally since the time of Aristotle, and were recognized in materia medica till the end of the eighteenth century. Now, since the alkaloid phrynin, found in the skin glands of the toad (and also to a slight extent in the frog) causes, when injected, contraction of the arterioles, rise of blood pressure, increased cardiac contraction, and so on, it is at least conceivable that it might be of some real service in ancient days.

I take a second illustration from the treatment of snake-bite. The venom in this case is well known to be of proteid nature, not alkaloid like that of toads and salamanders. It is the secretion of a specialized salivary gland. (a) The natives of several countries have been in the habit of drinking diluted snake poison to render themselves immune; this is certainly approached by the modern recommendation—e. g., by Prof. Fraser, of Edinburgh, and Dr. Calmette, of Paris, that an anti-toxin serum, prepared from snake venom, should be injected into the person bitten. (b) In many African snake medicines the bile of the snake is an important constituent; this is certainly approached by the recent evidence furnished by Fraser and Phisalix, that the bile of a venomous snake is an antidote, or even more than that, a preventive against the fatal effects of a bite. (c) An old Indian remedy for the bite of a certain snake is to chew the root of a labiate plant—Pogostemon puricaulis; this is certainly approached by the discovery of Phisalix, that the juice of the dahlia tubers, or of the fungus Russula, has immunizing properties against the viper's venom. Let us note the line of discovery, doses of bile neutralize venom (Fraser); biliary salts and cholesterin have, like the intact bile, a neutralizing or immunizing effect (Phisalix); vegetable cholesterin will work like animal cholesterin, and even tyrosin from the dahlia has the same important effect (Phisalix). Thus we come back to herbalist medicine again.

THE LION'S HEART AND NEWER LINKS.

Similarly let me remind you in a few words of an old-fashioned kind of remedy which, until recently, provoked only a smile from modern physicians. I refer to the prescriptions that the coward should devour the raw heart of the lion, that the weakly should eat the heart of an ox, that the lethargic should dine on a ram's brains, that the jaundiced should try the liver of a fox, and so on at great length. Yet surely there is some approach to this in the modern treatment of those unfortunate subjects whose thyroid glands have in some way gone out of gear, with the result that goitre or myxœdema ensues, for they are ordered to eat the thyroids of sheep or calf, or are treated with doses of thyroid extract. The results are apparently very effective; and the historical inference seems to me to be plain—that the old physicians were not such fools as they sometimes seemed.

But let me now give a few illustrations of what I would call newer links. The importance of having other organisms besides man to work with is at once a trite and difficult question, but let me recall a recent instance which can offend no one. It is said that the importance of the thyroid is somehow bound up with the iodine compound (thyreo-globulin), which it contains. But has not the matter been complicated by Prof. A. Gautier's paper of last year, in which he demonstrated in the normal thyroids of dog, pig, sheep and other mammals, besides man, the presence of minute quantities of arsenic? Though there are insensible quantities in the skin, arsenic is absent from the organs of the body, except thyroid, thymus and brain. In the thyroid it exists in combination with nucleins, along with the usual phosphoric nucleins. Does not this shed some light on the alleged advantage of arsenical medicines in treating diseases of the thyroid, and will it not lead us to translate "no health apart from the thyroid," into "no health without arsenic"?

PARASITES AS LINKS.

But let me now pass to illustrate another kind of link—namely, in connection with parasites. Here natural history and medicine have over and over again joined hands, and it does not seem too much to say that, without the labors of zoologists in working out life-histories and inter-relations, the medical treatment of parasites would have remained very empirical. The two illustrations which I take both concern mosquitos. As long ago as 1878 Dr. Patrick Manson called attention to the part played by mosquitos in spreading a minute threadworm parasite, well known as Filaria sanguinis hominis. His work has been confirmed by several workers, especially by Bancroft. Though the story has not been quite completed, it is almost certain that it will end as Manson and Bancroft predict. The story is this: The mature parasites live in the lymphatic vessels in man, and are by no means very small, measuring from 3 inches to 4 inches in length. They give rise to minute embryo filariæ, which live in the blood-vessels, swimming about when the host is sleeping, resting when he is active, perhaps because of the difference in the caliber of the capillaries during waking and sleeping hours. They cause very serious disease, which I need not try to discuss. Now, when a mosquito bites an infected subject during the night it takes away with the drop of blood some embryo filariæ. From the mosquito's stomach these embryos bore to its muscles, especially in the thorax, and grow with great rapidity for seventeen days. It used to be stated that the mosquitos only fed once and died within a week, but Bancroft points out that this was because the learned doctors omitted to feed the insects. By giving the introduced house mosquitos of Australia a little banana to suck, Bancroft kept them alive for weeks—indeed, for a couple of months. It is believed, though it has not been proved, that no further change will occur in the young filaria within the mosquito unless it pass somehow into man, there to develop into the full-grown worm of 3 inches or 4 inches. Bancroft has suggested that a life-sentenced prisoner might be of some use to the world if he could be induced to swallow some mosquitos bearing filariæ, on condition of receiving a free pardon. It is difficult to believe that a prisoner would, in the circumstances, strain at a gnat. But how does the filaria normally get into man? It used to be supposed that the exhausted mosquito fell into water tanks, that the filariæ emerged, and passed into man when he drank the infected water. But there is no evidence that the filariæ ever liberate themselves in this way from their mosquito host, and Bancroft has shown that the young filariæ put into water die in three or four hours. Therefore, water cannot be the vehicle of infection. It is now supposed either that man must swallow an infected mosquito or that he may put his finger into his mouth after killing one; or that, when an infected mosquito is biting man, the filariæ, excited by the entrance of the warm blood, may burst into the mosquito's gullet and pass down its proboscis into man. This part of the story remains obscure.

MOSQUITOS AND MALARIA.

That mosquitos play a part in infecting man with malaria is an old and widespread belief, to which recent experimental work has given a scientific basis. An elaborate argument in favor of the popular belief was published by King in 1883, and since that date many workers have made contributions toward a solution of the problem—Mansan and Ross in Britain, Laveran and Calmette in France, Koch and Pfeiffer in Germany, Bignani, Mendini, and Grassi in Italy. The question of priority is as difficult as it is tiresome. The general arguments in favor of the hypothesis, well summed up by Nuttall, are very suggestive: The malarial season usually corresponds with a period of warmth and moisture—conditions which favor the development of mosquitos; malarial regions are mosquito regions; devices which protect against mosquitos—curtains, cities, drainage and so on—also protect against malaria; these are three of the many general arguments. But, suggestive as these arguments are, they do not prove the correctness of the mosquito-malaria hypothesis. Experimental evidence was necessary, and it has been forthcoming. Following a suggestion of Manson's, Ross exposed malarial subjects in India to mosquitos, and observed that crescent-shaped parasites (Proteosoma) passed with the drops of blood from man to mosquito, and underwent a further development in the insect host. He also showed that only some of the many different kinds of mosquitos were suitable intermediate hosts for the malaria-parasite. Furthermore, he succeeded in producing malarial infection in birds—e. g., sparrows and crows—by means of infected mosquitos. He was led to the conclusion, since confirmed by others, that malarial infection results from the bites of mosquitos whose salivary glands contain the parasite. I need not try to follow the numerous researches of other workers, but it is important to notice that Grassi and Bignani succeeded in infecting a patient with malaria as the result of the bites of a mosquito (Anopheles claviger), and in tracing the development of the parasites in those same mosquitos after they had bitten a malarial patient. We have here a good instance of the confirmation of general arguments by experimental evidence.

THE VALUE OF A CONTROL EXPERIMENT.

But let us now notice the value of a control experiment. If malaria is due to the introduction of a parasite from the mosquito to the human blood, then there should be no danger in a malarial district provided

that the mosquito's bite can be avoided. This idea led to the erection of a mosquito-proof hut near Ostia, in one of the worst parts of the Roman Campagna, to serve as a cage for two volunteers who agreed to submit themselves to the test. Dr. L. Sambon and Dr. G. C. Low, of the London School of Tropical Medicine, arranged to live from May to the end of October in this hut, situated in a region "where scarcely a person spends a night without contracting malarial fever of a virulent type." No quinine or other drug was to be taken; the volunteers were to live in the mosquito-proof hut from an hour before sunset to an hour after sunrise, for the mosquitos feed only during the night. The experiment seems to have been quite successful. On September 13 Prof. Grassi and other investigators visited the hut, and sent this telegram to Manson: "Assembled in British mosquito-proof hut, having verified the perfect health of the experimenters among malarial-stricken inhabitants, I salute Manson, who first formulated mosquito-malarial theory.—Grassi." Similarly, Dr. Elliot reports that the members of the Liverpool expedition, sent this year to Nigeria, have been perfectly well after four months in some of the most malarious regions, and that they attribute their immunity to the careful use of mosquito nets.

As my chief interest at present is not with malaria, but to illustrate the scientific method, I ask your attention to another experiment. The story of the two volunteers on the Campagna is a fine illustration of scientific enthusiasm, and of confidence in scientific methods and results. What they have shown is that by avoiding mosquitos, or by getting mosquitos to avoid you, malaria is escaped. But it may be argued that this is only negative evidence. The question is whether malaria can be produced in a healthy person by the bites of infected mosquitos. In a recent number of The British Medical Journal it is stated that a consignment of mosquitos which had been fed on the blood of a malarial patient in Rome was received in London in July, and that a son of Dr. Manson, who had never been in a malarial country since he was a child, allowed himself to be bitten, and thereafter suffered from well-marked malarial infection of double tertian type. Microscopic examination of his blood showed the presence of numerous malarial parasites. This must be regarded as almost final proof of the hypothesis—shall we not say fact?—that malaria is transmitted by mosquito bites.

It is plain that in the solving of the practical problem of malaria the medical investigator has need of all the assistance that natural history can give him—e. g., as to the many different kinds of mosquitos and their habits, or as to the life history of the sporozoon parasite, which is the real cause of the disease. A knowledge of the breathing habits of the larvæ (familiar to us in common gnats) explains the success of a petroleum film as a means of killing them off in marshes; a knowledge of the appetite which various fresh water fishes have for them suggests another method of destroying them in ponds, and so on. On the other hand, since there is always action and reaction between science and its corresponding art, it must be frankly allowed that it is the practical importance of malaria which has led the British Museum entomologists to hurry on at present with a monograph on mosquitos.

PHAGOCYTES AND PROTOPLASM.

Let me illustrate another perhaps less obvious link. In almost all animals, from sponges to mammals, there are, within or apart from blood fluid, wandering amœboid cells, technically called phagocytes. As you know, they perform many functions both in health and disease. They form the bodyguard, struggling with invading bacteria; they surround and engulf irritant particles; they help to repair wounds, to regenerate lost parts, and so on. Phagocytosis has become to the pathologist a word of comfort, and perhaps there has been even some exaggeration of its importance. What I wish to point out is simply that much of the working out of the theory of phagocytosis has been in the hands of zoologists, as Metschnikoff shows clearly in his "Lectures on the Comparative Pathology of Inflammation." The beginning of it was in 1862, when Haeckel observed that grains of indigo injected into the mollusk Thetys were surrounded and engulfed by amœboid cells.

Or, again, you are, I believe, professionally interested in the influence of chemical reagents on the complex substances which we sum up in the term protoplasm. But that is obviously one of the perennial problems of biology. Let me recall one of the sensational researches of the last eighteen months, as the result of which Prof. Loeb announces that if eggs of sea urchins are transferred for a couple of hours to sea water to which magnesium chloride has been added (disturbing the normal proportions of salts), and are then replaced in their natural medium, they develop without fertilization and even form larvæ. It is too soon to say much about it; but here, obviously, if it is only to find out the fallacy, is one of the many problems where biological and medical or pharmaceutical students may profitably join hands.

A VICTIM OF OVER-EXERTION.

Finally, another illustration, which may seem at first sight almost further afield than the last. There are few subjects in medicine more important than nerve fatigue and nerve rest. Let me remind you of what I may call a natural history contribution to neurology. Is it not the case that almost from infancy many of us—especially those of us who are fond of laziness—have been urged to consider the little busy bee which improves each shining hour. A more intimate and critical knowledge of bees and their behavior entirely shakes our confidence in this exemplar of our childhood. I wish to lift only one corner of the seamy side by asking how the shining hour improves the busy bee. Whenever we ask this question we are struck by the fact that the worker hive bee has but a short life—often only for a few weeks after his industry begins. It is a victim to over-exertion. With all its getting, it gets not wisdom, but foolishness, for its brain cells go steadily and surely out of gear. Hodge compared the brain of bees issuing from the hive in the morning—when they were presumably fairly fresh—with the brain of bees who came last into the hive in the evening—presumably tired out—and demonstrated what, fifty years ago, would have excited great wonder—the structural effects of nerve fatigue.

The same striking contrast is seen when the brain of a young bee, fresh from the comb, is contrasted with that of a relatively old bee. A large number of cells have passed into what may be called a state of irrecoverable fatigue—collapse. As Prof. Hodge says: "The nerve cells, in the course of the bee's daily work, gradually cease to be functional and die off, until no more are left than are sufficient for the necessary vital functions." His work suggests that there are three grades of nervous fatigue in animals: (a) that from which recuperation is usual, what one might call the normal daily fatigue; (b) that from which recuperation is possible but difficult, which one might call extra wear and tear; and (c) that from which there is no recovery, the final functional collapse of nerve cells as in the bee's brain, and in some forms of old age. The state of the nerve cells in the brains of some hibernating animals is also very interesting in this connection. I am not competent to follow the matter further, e. g., in application to man, but I think the suggestiveness of a contribution like this must be plain to all. At any rate, I recommend a reconsideration of the little busy bee, but in a scientific rather than in a poetical light. The story of the bee's brain is a warning against over-industry, and one of the sections in the apology for rest.

CONCLUSION.

I have then illustrated some of the ways in which natural history has been linked to medicine and some of the links that remain to the great advantage of both. But my illustrations do not cover a tithe of the real and possible kinds of links, nor have they suggested at all that the deepest service of natural history is probably in helping to lay the biological foundation stones on which the stately edifice of medicine, both curative and preventive, is reared.

I have mentioned a variety of animals—the leech, the toad, the snake, the mosquito, the bee, the sea urchin, and so on—but the possibility of illustration is endless. Perhaps in the study of every animal one may find some suggestion of service in the study of man. As I was thinking of this, a Japanese waltzing mouse came dancing into the focus of my consciousness. But it is as good an illustration as any other, though it may not at first sight seem promising. The mouse moves only sideways, neither backward nor forward, and surely it becomes at once interesting medicinally in connection with defective equilibration and the like in man, when we note Von Cyon's discovery that it has only one of the usual three semi-circular canals developed.

Even in my few illustrations I have probably made mistakes by touching subjects which are beyond my field of work, but to pounce upon these is to ignore the whole aim of my address, which is to suggest that the various departments of science—yours and mine and that of others—are all correlated. It is not solely by the aloofness of specialism and the pre-occupation of expert research, but by mutual interest and active cooperation as well, that we make progress in understanding the one problem which, in some form or other, is before us all—the Order of Nature. And it is this valuable width of scientific interest and sympathy which an actively functional society like this is well suited to foster.

THE BACTERIAL SELF-PURIFICATION OF STREAMS.

During the construction of the Illinois and Michigan Canal, and especially when it was approaching completion and the sewage of Chicago was to be turned into the Mississippi River, many of the people of St. Louis, it will be remembered, were in a state of dread lest their drinking water, drawn from the Mississippi, should be dangerously contaminated as the result, says The New York Medical Journal. The flow has now been going on for some months, however, and the alarm appears to have been needless. Given sufficient time and sufficient distance, and flowing water, even water flowing sluggishly, will free itself from pathogenic bacteria. It is of no little importance to know what agencies are at work in any given instance to bring about this spontaneous self-purification. Instructive studies of the waters of various European rivers—such as the Spree, the Pregel, the Danube, the Limmat, the Isar, the Rhine, and the Seine—have been published from time to time during the last few years, and some work in the same direction has been done in this country. The most recent and one of the most notable of American investigations of this sort has been conducted by Edwin Oakes Jordan, Ph.D., of the bacteriological laboratory of the University of Chicago, who contributes a condensed account of his observations to the December number of The Journal of Experimental Medicine.

Dr. Jordan summarizes a number of the best-known European investigations, but points out that, while their general purport points unmistakably to a lessening of the bacterial contents of the water, whether it is due to dilution, to sedimentation, or to the action of sunlight, great differences exist in the degree of apparent purification, depending upon the amount of initial pollution, the velocity of the flow, the season of the year, and other elements. Each stream, he remarks, seems to have its own conditions, and conclusions drawn from an examination of any one cannot be applied to another; each stream must be subjected to detailed special observation. His own work, though nominally limited to the Illinois River and its tributaries, really included observations at various points, ending as far away from Chicago as at Chain of Rocks, on the Mississippi, whence the St. Louis water supply is obtained. The results are recorded largely in tabular form. The tables, thirty-eight in number, give each the results of a series of examinations for each locality, in most instances between twenty-five and thirty, made a few days apart during the period from May to December.

At Bridgeport, on the canal itself, the number of bacterial colonies in a cubic centimeter of water ranged from 225,000 to 1,850,000; at Lockport, also on the canal, from 40,000 to 1,650,000; at the same place, but in water from the Desplaines River, from 1,250 to 34,000; above Joliet, in the same river, from 20,000 to 1,620,000; below Joliet, from 120,000 to 2,540,000; at Wilmington, in the water of the Kankakee River, from 1,400 to 25,700; at Morris, in the water of the Illinois River, from 16,000 to 1,140,000; at Ottawa, in the water of the Fox River, from 450 to 34,500; above Ottawa, in the water of the Illinois River, from 650 to 130,000; at La Salle, in the water of the Big Vermilion River, from 1,400 to 62,000; at the same place, in the water of the Illinois River, from 700 to 228,000; at the same place, in the water of the canal, from 16,000 to 152,000; at Henry, in the water of the Illinois River, from 500 to 74,000; at Averyville, in the water of the same river, from 500 to 19,500; at Wesley City, in the water of the same river, from 5,000 to 3,390,000; at Pekin, in the water of the same river, from 5,000 to 2,030,000; at Havana, in the water of the same river, from 850 to 128,000; at Chandlerville, in the water of the Sangamon River, from 1,200 to 11,600; at Beardstown, in the water of the Illinois River, from 1,500 to 120,000; at Kampsville, in the water of the same river, from 340 to 23,500; at Grafton, in the water of the same river, from 180 to 97,000; at the same place, in the water of the Mississippi River, from 800 to 45,000; at Alton, in the water near the eastern bank of the Mississippi, from 900 to 39,000; at the same place, in the water east of the middle of the river, from 900 to 40,400; at the same place, in midstream water, from 700 to 27,500; at the same place, west of the middle of the river, from 700 to 25,500; at the same place, near the western bank of the river, from 650 to 37,500; at West Alton, in the water of the Missouri River, from 2,100 to 20,900; at Chain of Rocks, in the water of the Mississippi (eastern bank), from 1,300 to 113,000; at the same place (midstream), from 1,600 to 68,000; at the same place, at the inlet tower of the St. Louis water works, from 1,800 to 69,000; at the same place (western bank), from 2,700 to 57,500; at St. Louis (tap water), from 340 to 2,790; at Jefferson Barracks, in water near the eastern bank of the Mississippi, from 1,000 to 69,000; at the same place, in the water east of the middle of the river, from 1,700 to 42,000; at the same place (midstream), from 2,700 to 56,500; at the same place, in water to the west of the middle of the river, from 3,200 to 91,600; at the same place, in water near the western bank, from 4,900 to 65,300.

It is estimated that 85 per cent of the sewage of Chicago is carried into the Illinois River. Dr. Jordan gives the following averages of the numbers of bacterial colonies found at various points on the canal, the Desplaines River, and the Illinois River: Bridgeport (practically Chicago), 1,245,000; Lockport (29 miles away), 650,000; Joliet (33 miles away), 486,000; Morris (57 miles away), 439,000; Ottawa (81 miles away), 27,400; La Salle (95 miles away), 16,300; Henry (123 miles away), 11,200; Averyville (159 miles away), 3,660; Wesley City (165 miles away), 758,000; Pekin (175 miles away), 492,600; Havana (199 miles away), 16,800; Beardstown (231 miles away), 14,000; Kampsville (288 miles away), 4,800; Grafton (318 miles away), where the junction with the Mississippi River is effected, 10,200.

No doubt the reader has been struck with the sudden and decided increase of bacteria at Wesley City, following upon a gradual and steady diminution from Chicago. This is attributable to the large amount of organic refuse that finds its way into the Illinois River with the sewage of Peoria reinforced by the waste of manufactories, distillery slop, discharges from glucose factories, and the sweepings of extensive stock yards. The Wesley City specimens of water were taken from a point about four miles below this "outpour of pollution," which is said to vary greatly at different seasons of the year and at different hours of the day, thus accounting for the great irregularities and fluctuations in the number of bacteria observed at that point. Beyond Wesley City the gradual process of self-purification goes on as before. Taking the purifying process, then, as practically continuous, we at once find ourselves interested in what Dr. Jordan has to say of the elements concerned in it. Before proceeding to present this, however, we must remark that he quite frankly points out that the observations are open to criticism on the score that the specimens of water examined were transported, and for the reason that they were not taken simultaneously from the different points. It seems that the bacteria multiply when the specimens are not packed in ice, and that in ice-packed specimens they decrease in number at first, but subsequently multiply to a number exceeding in some instances the original proportion. Allowance being made for these sources of error, which in some measure probably correct each other, it is not to be doubted that the general drift of the observations and of the deductions drawn from them may be taken as correct.

Among the supposed causes of the gradual disappearance of bacteria, Dr. Jordan first considers mechanical agitation and aeration. In so sluggish a stream as the Illinois, he says, there is not sufficient agitation to prove at all injurious to bacterial life; indeed, Meltzer's experiments point to the conclusion that moderate agitation is not detrimental to bacteria. Aeration of the water to the extent to which it takes place in a river of slow flow may also be dismissed as having little effect in promoting the destruction of micro-organisms. The immediate effect of dilution with purer water from underground sources or from tributaries must, however, be in the direction of diminishing the proportion of bacteria in a given quantity of water, and Dr. Jordan finds it difficult to understand, as we do also, why this effect is sometimes referred to as not being a "true" purification. If, he says, a sample of water contains a hundred typhoid-fever bacilli to the quart, and is diluted to twenty times its bulk with pure water, each quart will contain only five germs, and, "apart from any influence the dilution may have upon the life of the germs, a purification of the water will have occurred to just the same extent as if 95 per cent of the typhoid bacteria had perished, and the danger from drinking a small quantity of such a water would be diminished in exactly the same proportion."

As regards the action of sunlight, ordinarily accounted a potent element in aerial purification, the author is not prepared to make any definite statement, but remarks that such incidental evidences as were gathered do not warrant the attachment of great importance to it. The main bulk of a body of water, if even moderately high turbidity prevails, must, he thinks, be virtually unaffected by the sun's rays. Still, he does not affirm that they are always and entirely without effect upon the bacteria in river water, "although they certainly play an insignificant part in the case of turbid waters." The influence of the plankton, he remarks, is perhaps yet more problematical than that of sunlight, either by devouring the bacteria themselves or by consuming their means of sustenance. In the first place, he says, the albuminous substances that serve as food for bacteria cannot be so advantageously attacked by the plankton as by the bacteria; in the second place, there is ample laboratory evidence that a bacterial decrease always follows close upon a bacterial multiplication in sewage or polluted waters containing no plankton. In sedimentation Dr. Jordan finds a more potent element. When there is semi-stagnation of the water, he says, "the settling out of food substances, the entanglement of bacteria in slowly subsiding particles, and possibly the slow sinking of the bacteria themselves, all have the fullest play, and must all work to diminish the number of suspended bacteria." "There can be no doubt," he adds, "that the various influences summed up by the term sedimentation are sufficiently powerful to obviate the necessity for summoning another cause." Nevertheless, he thinks that due weight is not generally attributed to diminution of the substances, minute floating albuminous masses, upon which the bacteria subsist, and there is no need to assume that their diminution is wholly, or even in large part, due to the process of sedimentation. He makes this important statement: "I have been struck by nothing in the course of the investigation so much as by the absence of extensive deposits of the foul, black mud popularly supposed to accumulate on the bottom of sewage-polluted rivers. The bed of the Illinois between Morris and Ottawa is singularly free from any deep deposit of organic matter, although the current is very sluggish and sewage in increasing quantities has been poured into the river for thirty-five years. The solid organic matter in the sewage, therefore, is destroyed either while still in suspension or shortly after deposit. The natural effect of this shrinking of the food supply is to cause a diminution of the bacterial population dependent upon it."

AFTER THE FIGHT AND PILLAGE IN PEKING.

COFFEE DRINKING IN THE UNITED STATES.

THE use of coffee in the United States has attained enormous proportions and so long as it is not consumed to excess its universal consumption is a healthy sign. At any rate, the habit is preferable to that of alcohol; but, as with alcohol, the bounds of discretion may be passed, and when this occurs coffee may and often does exert extremely deleterious effects. In The Medical Record, January 12, Dr. Leszynsky reviews the subject from this standpoint, and shows where coffee is useful and where it is harmful. It is pointed out that caffeine, to which is due the larger part of the physiological action of coffee, is an absolute poison to some persons, while on others no injurious effect whatever would seem to be produced. The former class are of the neurasthenic type. The advice is wisely offered that coffee should never be given to young children. With regard to the symptoms of acute and chronic coffee poisoning, Dr. Leszynsky remarks that between these conditions there is a peculiar difference. In the former, when coffee is taken in large doses by persons unaccustomed to its use, it produces excitability to the degree of delirium, etc. In the latter, which is of greater importance on account of its more frequent occurrence, the toxæmia manifests itself as a depressive form of neurasthenia. In brief, the symptoms of chronic coffeeism are indicative of interference with the nutrition of the cells of the cerebro-spinal system resulting from over-stimulation and auto-toxæmia, and correspond very closely with the symptoms of chronic alcoholism, for which it is often mistaken. The fact is undoubted that coffee has an injurious effect upon many people, and it is also as undoubted a truth that excessive indulgence in the beverage so loved of our European ancestors does good to no one. At the same time, it is to be hoped that coffeeism may not become prevalent among Americans, and that its toxic effects have been somewhat exaggerated. The habit which is followed by some persons in this country of drinking two or three cups of coffee at lunch or dinner when eating meat is greatly to be deprecated, as it must, in the nature of things, disturb digestion, and will, if persisted in, permanently weaken the digestive powers. Coffee, partaken of judiciously, is an excellent form of liquid refreshment; but we would add the saving clause that it must be of good quality and properly made—the latter being almost an art in itself.

THE LOOTING OF PEKING.

AT the outbreak of the present Chinese troubles Europe and America were aghast at the harrowing tales of the outrages committed by the Boxers. To-day civilized nations have every reason to be ashamed of deeds committed by their troops, which in cruelty and wantonness surpass those of the Boxers.

For the last two months the magazines and newspapers have been filled with letters and articles by officials and correspondents in China, in which the inexcusable ravages of the allies are pictured in the most glaring colors. Sir Robert Hart, the British Inspector-General of Chinese Customs, a man who has passed the most active part of his life among the Chinese, has said that the "days of Taipingdom, when native warred with native, showed nothing worse" than the atrocities of the foreign troops in China. If Mr. Thomas F. Millard's account in Scribner's Magazine is to be credited, the "punitive expeditions" sent out against suspected Chinese villages have been exceeded in brutality only by the Sepoy outrages. The Pao-Ting-Fu expedition wiped out a hundred unarmed villagers at Chao-Pei-Khon, "most of whom were sabered while on their knees praying for mercy." It is true that the French soldiers took no part in the slaughter at Pao-Ting-Fu; but they looted the treasury of 100,000 taels. In three days Pao-Ting-Fu was deserted, so fearful were the inhabitants of the foreign soldiers. Rather than face the invaders whole families committed suicide. It is refreshing to find that the American troops have not been concerned in these raids on innocent villagers.

Compared with the murder of thousands of Chinese the looting of Peking glows white and benign. In the pillage that followed the taking of the capital all the troops more or less took part. The Japanese and American officers were the first to take their men in hand and to repress and punish looting.

The story is in certain respects the story of the opium war told over again with bloody emphasis. In 1839 the Chinese sovereign dispatched his ablest functionary to Canton to stem the stream of opium illicitly imported. "How can I die and meet my imperial ancestors until this direful evil is removed?" is the remark said to have been made by the Emperor. At the cannon's mouth Canton was bombarded by the British and an enormous ransom demanded. Peking was later captured and the Emperor's palace looted then as now.

For the depredations of the Boxers the Powers have demanded an indemnity. It remains to be seen whether Li Hung Chang's just request that the value of the loot carried off by the soldiers be deducted from that indemnity, will be considered.

PROGRESS OF AGRICULTURE IN THE UNITED STATES.

By GEORGE K. HOLMES, Assistant Statistician, United States Department of Agriculture.

CRUDE BEGINNINGS BY INDIANS.

INDIANS carried on agriculture in a primitive and very limited way in the region now embraced in the United States before the country was inhabited by the white race, and to their crude agriculture they joined the harvesting of the wild products of nature.

Some Crops and Methods of Cultivating and Gathering.

Indian Corn.—The farming practised on the eastern side of North America by the Indians was to burn off the forest, scrape up the top soil into little hills, and, if corn was to be raised, to plant the seed therein. Indian corn, or maize, was indigenous, and the Indians raised it from time immemorial. Women did the work, and the only implements employed were their fingers, a pointed stick for planting, and a clam shell or the scapula of an animal for a hoe. At the time of harvest the ears of corn were stored in a cache, or were hung up to dry, held together by the braided husks.

Tobacco.—Tobacco was another plant indigenous to America, and the Indians, who had learned its narcotic property, were in the habit of smoking the leaves after they had been dried.

Food and Textile Plants.—The Indians of northern California gathered the seeds of wild plants and roasted them on hot stones, to be ground afterward into coarse flour by a stone operated in a hollow in a rock. Mojave Indian women planted gourd seeds in the crevices of rocks, and when the gourds were ripe gathered enormous quantities of them. Especially along the whole western coast of North America Indian women gathered wild hemp, agave, and other textile plants; they dried the leaves or stalks, macerated them in water, extracted the fiber and spun it on their naked bodies without the use of any implement whatever, and then made fabrics for domestic use.

Wild Rice.—Throughout the Great Lake country the Indian women beat the heads of the wild rice plants while holding them over their canoes; having fanned the chaff away by using a large tray, they ground the rice in a mortar and cooked it in much the same way as corn.

Wild Cherries and Roots.—The Sioux Indians beat dried wild cherries with buffalo meat to form their winter stock of pemmican. In Oregon and Washington an immense amount of food was gathered from the camass root, and also from the kouse root.

Fruits, Nuts, etc.—The Indians gathered the indigen-

ous strawberries, huckleberries, blackberries, raspberries, cranberries, etc., and the chestnuts, butternuts, hickory nuts, walnuts, hazelnuts, and beechnuts. They lived also upon fish and the flesh of deer, bear, buffalo, and other wild animals, both fresh and dried.

BEGINNINGS OF AGRICULTURE BY THE WHITE RACE.

Next the white man came. Poor in the materials of wealth, indeed almost destitute of them, a stranger in a strange land with a strange climate, and beset by native enemies, the white settler had in prospect a simple subsistence upon a few products of a crude agriculture and an insignificant dairy, with such fabrics and other products as might be obtained from a primitive domestic industry. He saw the golden ears of maize strung up in the wigwams of the Indians and learned its value as food; he learned how to plant it, and also the value of putting fish for fertilizer under the seeds.

Early Colonial Conditions.

Typical references to early colonial conditions are selected from Prof. McMaster's "History of the People of the United States;" from Mr. Weeden's "Economic and Social History of New England," and from Prof. Bruce's "Economic History of Virginia in the Seventeenth Century."

In Georgia in 1790 the staple was tobacco, cultivated in the simplest manner, with the rudest of tools. Agriculture as we now know it can scarcely be considered to have existed. The plow was little used. The hoe was the implement of industry; made at the plantation smithy, the blade was ill formed and clumsy, and the handle was a sapling with the bark left on. After a succession of crops had exhausted the soil the cows were sometimes penned upon it.

THE HAVOC WROUGHT BY A MINE EXPLODED AT PETANG.

In Virginia the poor whites, who had formerly been indentured servants, were the most lazy, the most idle, the most shiftless, and the most worthless of men. Their huts were scarcely better than negro cabins; the chimneys were of logs, the chinks being filled with clay. The walls had no plaster, the windows had no glass, and the furniture was such as they themselves made. Their grain was thrashed by driving horses over it in the open field; when they ground it, they used a rude pestle and mortar, or placed it in the hollow of one stone and beat it with another.

Each family in New England lived in a state of almost entire independence of other families and of all other communities than the one in which it lived. Beef or pork, generally salted, salt fish, dried apples, bread made of rye or indian meal, milk, and a very limited variety of vegetables constituted the food throughout the year. The Massachusetts farmer who witnessed the Revolution plowed his ground with a wooden plow, sowed his grain broadcast by hand, and when it was ripe cut it with the scythe and thrashed it on the barn floor with a flail. His house was not painted; his floor was not carpeted. When darkness came on his light was derived from a few candles of home manufacture. The place of furnaces and stoves was supplied by huge cavernous fireplaces which took up one side of the room and, sending half the smoke into the apartment, sent half the heat up the chimney. The farmer and his family wore homespun. If linen was wanted, the flax was sown and weeded, pulled and retted, and broken and swingled, for all of which processes nearly a year was required before the flax was ready for spinning, bleaching on the grass, and making and wearing. If woolens were wanted, sheep were sheared and the wool was dyed and spun and woven at home.

It was almost invariably true of all the settlers that the use and value of manures was little regarded. The barn was sometimes removed to get it out of the way of heaps of manure, because the owner would not go to the expense of removing these accumulations and putting them upon his fields.

In comparison with present conditions, the farmer's life in colonial days was a dreary one, filled with hardships and deprivations, and treading very closely upon the margin of subsistence. Those conditions continued after the Republic had been established, and were not measurably ameliorated until the past century had well advanced—until an improved intelligence, the dissemination of information, and especially the work of the inventor had begun to take effect.

*First Crops.**

Cereals.—The first yield of indian corn, or maize, in any considerable quantity produced in the United States by people of English blood of which we have any authentic record was that of 40 acres in the Jamestown Colony in 1609.† Wheat was first sown in Massachusetts on the southern coast as early as 1602, and it was first cultivated in Virginia in 1611. Rye dates back in New England certainly to 1648, and perhaps to 1630, and oats and barley to Gosnold's Colony in 1602.

Buckwheat.—The first cultivation of buckwheat dates back to 1625 or 1626, on Manhattan Island.

Potatoes.—Plymouth Colony cultivated potatoes as early as 1629.

Beans.—Beans have the date of 1602 on islands south of Massachusetts, the date 1644 at Manhattan, and about the same date in Virginia.

Fruits.—The first apples raised in this country were possibly from trees planted on Governor's Island in the harbor of Boston, from which, on October 10, 1639, "ten fair pippins" were brought. Governor Endicott had on his farm in Salem, now Danvers, Mass., in 1640, the first nursery of young fruit trees that was ever planted in this country.

Tobacco.—The English first saw tobacco cultivated and smoked in clay pipes by the Indians of Virginia in 1585, and the cultivation of tobacco was introduced into the Dutch Colony of New York as early as 1646, when it sold for 40 cents a pound.

Flax and Hops.—Flax was taken to Holland from Manhattan Island as early as 1626. Hemp and flax were raised in Virginia prior to 1648. Hop roots were ordered by the governor of Massachusetts Bay as early as 1628.

Silk.—Silk culture was begun in Louisiana by the Company of the West in 1718. It was introduced into Georgia in 1832. Connecticut began the production of silk in 1760.

Sugar Cane.—Sugar cane was first introduced into Louisiana in 1751, and the first plantation was established in 1758.

Rice.—The culture of rice was introduced into the colony of Carolina about 1694, the seed being obtained by the governor of the province from a ship from Madagascar.‡

Cotton.—A pamphlet published in London in 1609 predicts that cotton would grow as well in Virginia as in Italy, and the author of another pamphlet, published in 1620, mentions cotton as a product that may be had in abundance in Virginia; but Bancroft's History of the United States says the first experiment in cotton culture in the Thirteen Colonies was made in Virginia in 1621, when the cotton seeds were planted as an experiment, and their "plentiful coming up" was at that early day a subject of interest in America and England. Cotton wool was listed in that year at 8 pence a pound, which indicates that it may have been grown earlier.*

* Most of the statements under this head are ta: 'u from Eighty Years' Progress of the United States (1861).

† Bruce's "Economic History of Virginia in the Seventeenth Century," Vol. I, p. 198.

‡ Pitkin's "Statistical View of the Commerce of the United States of America" (1816), p. 97.

First Domestic Animals.

For many months after the arrival of the Pilgrims at Plymouth they had no beasts of burden; when at la . a few cows were brought over they were poorly fed on the coarse wild grasses, and often they died from exposure and want of proper food or fell a prey to the wolves or the Indians. Owing to the difficulties and expense of importation the price was so high as to put them beyond the reach of many even in moderate circumstances. In the colony of Massachusetts Bay a red calf soon came to be cheaper than a black one on account of the greater probability of its being mistaken for a deer and killed by wolves.

Cattle.—When cows were so high as to sell, in 1636, at from £25 to £30 sterling at Plymouth and oxen at £40 a pair, a quart of new milk could be bought for a penny. The ox of that day was small, ill-shaped, and in every way inferior to the ox of the present time. During the early part of the last century the average gross weight of the neat cattle brought for sale to the Smithfield market was not over 370 pounds.

Dairy cattle were first brought to Virginia in 1611 and to Plymouth in 1624, from the coast of Devonshire. Some of the Virginia cattle were from the black cattle of Spain, and those brought tc New York, possibly from the island of Texel, on the coast of Holland, were mostly, without doubt, the black and white Dutch cattle. Those on the Delaware were brought from Sweden; those in New Hampshire were the large yellow Danish cattle, and, as the earlier importations were the most extensive that were made for many years, these various stocks were crossed and thus formed the original stock of the country.

The cattle along the northern Atlantic coast fared miserably in winter, having little or no protection from storms and cold and being poorly fed on hay made from overripe swale grass and salt grass cut from the marshes. It was a common opinion in the Virginia Colony that the housing and milking of cows in the winter would kill them.

Horses.—The first horses taken from Europe to the Western Hemisphere were brought over by Columbus on his second voyage, in 1493. In 1527 forty-two horses were landed in Florida and perished soon after their arrival. The wild horses of the Southwest are probably descendants of the fine Spanish horses abandoned by De Soto on the failure of his expedition. In 1604 a French lawyer brought over horses to Acadia, and these probably laid the foundation of what are now known as Canadian ponies. In 1609 horses were brought to Jamestown, and in 1629 they were introduced into the colony of Massachusetts Bay. Horses were brought to New York in 1625 from Flanders. These importations seem to have been the original stock from which the race of American horses was constituted. But the horses of the United States, as in the case of other farm animals, have been much improved and diversified in special qualities during

* "The Cotton Plant;" published by the United States Department of Agriculture, pp. 30 and 31.

the last twenty-five years or so by the importation of thoroughbreds from Europe and by well-directed breeding.

Sheep.—It is probable that the first sheep in this country came to Virginia in 1609 from England. About 1625 some sheep were brought to New York by the Dutch West India Company from Holland. Sheep were brought into the Plymouth Colony and that of Massachusetts Bay very soon after the settlement.

Swine.—De Soto prbably brought the first swine into this country in 1538 from Cuba, and these were landed in Florida. They were probably descended from some brought over by Columbus in 1493. The Portuguese brought swine into Nova Scotia and Newfoundland as early as 1653. The London Company imported swine into Virginia in 1609. They were introduced into the Plymouth Colony in 1624 by Governor Winslow, and into New Netherlands, now New York, in 1625 by the Dutch West India Company.

TRANSITION TO MORE RECENT CONDITIONS.

Although the early white settlers immensely improved and expanded the agriculture of the Indians, it is nevertheless true that in comparison with the agriculture of the present time that of the previous century and of the earlier half of the past century was crude, wasteful, uneconomical, expensive, laborious, and unscientific. The transition from the old to the new was gradual, but, having in mind long periods of time, it is apparent that American agriculture has had two distinct periods with regard to the characterization above specified. The change has been rapid since the civil war, and the last thirty years or so stand out conspicuously as belonging to a period of development and results having little similarity to the long preceding period beginning with the eighteenth century and approaching an end about the middle of the past one.

In this paper only a brief mention will be made of some of the causes and opportunities of the agricultural expansion of the country.

Expansion of Population.

The principal opportunity for agricultural expansion was the immense cultivable area of virgin soil awaiting primarily to be despoiled of its fertility, which was subsequently to be partly restored and maintained by means of fertilizers.

The necessity for this expansion was a rapid and permanent growth of sturdy population, derived not merely from a natural increase, but largely from an unprecedented immigration from the peasant laboring classes of Europe—people who had been unable to obtain the ownership of land in a country of primogeniture, as well as people who had failed in other countries where land values were beyond their reach, and who came here with "a land hunger," where they found millions of fertile acres awaiting their acquisition at a cheap price.

The population of this country, according to the census of 1790, was 3,929,214; in 1850 it had increased to 23,191,876; in 1860, to 31,443,321; in 1880, to 50,155,783; in 1890, to 62,622,250; and various estimates of the population in 1900 place it at a figure somewhat above 75,000,000. Immigrants, who are included in these figures, numbered 143,439 in the ten years 1821-1830; from about 2,500,000 to 3,000,000 in each of the ten-year periods beginning with 1851 and ending with 1880, and 5,246,613 in the ten years 1881-1890. From 1891 to 1899, inclusive, the number was 3,396,011.

The Non-Agricultural Population.

Since the birth of the nation there must be taken into account also the great and relative increase in the city population, which must derive its subsistence mainly from the agriculture of this country without contributing to agricultural production. The population living in cities and towns of 8,000 or more was 3.35 per cent of the total in 1790, 12.49 in 1850, 22.57 in 1880, 29.20 in 1890, and perhaps is about 35 per cent at the present time, or more than one-third of the entire population.

These percentages do not include the inhabitants of villages, towns, and the smaller cities not engaged in agriculture, who, if included, would swell the percentage above 35.

There has been a further marked increase in the non-agricultural elements of the population. In 1870 the persons 10 years of age and over who were engaged in manufacturing and mechanical industries were 19.61 per cent of the total number of persons of that age having gainful occupations, and this percentage had increased to 22.39 in 1890. It may easily be 25 per cent at the present time.

The number of persons employed in trade and transportation has increased from 9.83 per cent of the total number of persons employed in all occupations in 1870 to 14.63 per cent in 1890.

The percentage for persons engaged in professional services has increased from 2.97 in 1870 to 4.15 in 1890. For domestic and personal service the percentage has increased from 18.48 in 1870 to 19.18 in 1890.

The census group of occupations embraced within agriculture, fisheries, and mining is represented by 49.11 per cent in 1870, or nearly one-half of the persons having gainful occupations, and fell to 39.65 per cent, or about two-fifths, in 1890, and is likely to be hardly more than one-third at the time of the Twelfth Census (1900).

Public Land.

While marked increase in the demand for agricultural products for consumption by persons who are in non-agricultural occupations has thus occurred, the government at the same time has offered to agricultural producers a vast area of land at hardly more than a nominal price. Previous to July 1, 1897, final homestead entries to the number of 529,051 had been made for 70,396,856 acres belonging to the national government; the number of entries in the following year was 22,281, covering 3,095,018 acres, and in the year previous to July 1, 1899, the number was 22,218, covering 3,134,149 acres—total to 1899, entries, 573,550; acres, 76,626,023.

During the twenty-two years preceding July 1, 1897, the public and Indian lands disposed of for cash and under the homestead laws, under the timber-culture laws, located with agricultural college and other kinds of scrip, located with military bounty land warrants, and selected by States and railroads embraced 299,961,357 acres; in 1898, 8,453,897 acres; in 1899, 9,182,413 acres—total for twenty-four years, 317,597,667. Some of the States and many railroad companies have been selling land, mostly for farms, amounting in the aggregate to a vast area. The number of sales on credit of tracts of land large enough to be measured by acres, from 1880 to 1889, inclusive, was 60,431 by States and 140,190 by railroads.

Causes of Increased Production.

While the country has been developing as above indicated, the great non-agricultural populations of European countries have been relatively increasing, and have exhausted in their consumption the farm production of their own countries, especially with respect to the items of wheat, corn, and other cereals, animal and dairy products, and, to the very small extent of cultivation, tobacco and cotton, thus opening up a foreign market, which has in a large degree warranted the expansion of the agriculture of the United States, along with the other causes or opportunities mentioned.

The decided decline in the cost of transportation has also contributed largely to the transformation under consideration.*

Implements and Machines.

The most prominent feature in the development of American agriculture is the immense improvement that has taken place in agricultural methods and machines—indeed, the word improvement is not adequate to express the change that has taken place in the methods of agriculture in this country, because the implements and machines are creations rather than improvements, and their mission has been radical and far-reaching. They have reduced the amount of human labor required to produce a given quantity of crops and to cultivate given areas of land, and they have been largely, if not chiefly, instrumental in converting local markets into world markets for the principal cereals, cotton, tobacco, and animal and dairy products.

A technical description of these implements and machines cannot be attempted here, and it will be sufficient merely to indicate generally changes in their character and in the results of their work. Dependence must be placed upon the reader's knowledge of these machines and upon his mechanical mind to understand how and why they have contributed so much to the realization of the present agricultural era.

Vehicles.—At the beginning of this century carts were used on the farms and chaises on the roads. Stage coaches were used on the main roads of travel, and a few wagons were found here and there. Carts were more convenient for use with oxen on the farms. For many years discussion was active as to the comparative economy of oxen and horses for farm use, and wagons came in with the increased use of horses and the improvement of the country roads. Buggies and trotting horses grew up together. Light one-horse wagons first appeared in Connecticut about 1830, but it was not until 1840 or later that they became common enough not to attract notice when seen on the roads.†

Plows.—In 1637 there were but 37 plows in the colony of Massachusetts Bay. Twelve years after the landing of the Pilgrims the farmers around Boston had no plows, and were compelled to break up the ground and prepare for cultivation with their hands and with rude and clumsy hoes and mattocks. It was the custom in that part of the country, even to a much later period, for anyone owning a plow to do the plowing for the inhabitants over a considerable extent of territory. A town often paid a bounty to anyone who would buy and keep in repair a plow for the purpose of going about in this way.‡

Mr. C. C. Coffin thus mentions the plow that his father used: "I think it was about 12 feet long. I know that it required eight to ten oxen to draw it, one man to ride upon the beam to keep it in the ground, and a man to follow behind with a heavy iron hoe to dig up the baulks."§

A writer in The Rhode Island American in 1820 describes the plow generally in use in the Eastern States at that time, known as the Old Colony plow, as follows: "It had a 10-foot beam and 4-foot landside; your furrows stand up like the ribs of a lean horse in the month of March. A lazy plowman may sit on the beam and count every bout of his day's work. Six of these plows cost me on an average, last year, $5 each to keep the shares and colters fit for work, and the wear of the other parts could not be less than $1 more—$6 per year for each plow."

The first patent for a plow in this country was taken out by Charles Newbold, of New Jersey, in 1797. His was the first cast iron plow ever made, but the farmers in those times entertained great prejudices against it. There was a general idea throughout the country that a cast iron plow would "poison" the land. Mr. Coffin remembers the first cast iron plow used in his neighborhood in New Hampshire in 1837 and the assemblage of farmers who objected to it for the reason mentioned. He says that it required from 1797 to 1842 for the inventive genius of this country, together with the observations of farmers and mechanics, to arrive at any just conclusion as to what would be the best form for the plow.

Without mentioning intermediate plows, it will be sufficient to pass on to the Oliver chilled plow, which first appeared in 1870. This was a light, durable plow, with a mold board of proper shape to economize draft and suitably turn the furrow, and this plow in a marked degree promoted the economy of plowing. It was stated by Mr. Coffin in 1878 that this invention, if used throughout the United States in the preceding year, would have effected a saving of $45,000,000 to the farmers of the country in the expense of plowing.

And then invention followed invention and improvement followed improvement, until we have sulky plows, gang plows, plows combined with harrow cultivators, and with seed drills, side-hill plows, vineyard plows, beet plows, subsoil plows, double land-side plows, and, lastly, what has been the aim, and seems to be the end, of plow invention, we have the steam gang plow combined with a seeder and a harrow, which has reduced the time required for human labor (in plowing, sowing, and harrowing) to produce a bushel of wheat, on an average, from 32.8 minutes in 1830 to 2.2 minutes at the present time, and which has reduced the time of animal labor per bushel from 57 to 1½ minutes; at the same time it has reduced the cost of human and animal labor in plowing, seeding, and harrowing per bushel of wheat, from 4 cents to 1 cent.

Corn Planters.—Hundreds of patents have been issued for corn planters. The earlier ones were adjustments to the hoe, which permitted the release of grains of corn when the hoe was struck into the ground; then came the hand planter, and the next step was the horse drill. Next came the idea of marking rows in both directions with a drag. A long beam with pins in it was dragged both ways across the field by horses, and then the farmer would go along with the hand planter and plant the corn at the intersection of the rows. Still, again, followed an improvement, and this was the corn planter which planted two rows at one time with the rows running in both directions. A man sat on the machine, and, at every point where the drag had crossed at right angles, he moved a lever that dropped the corn, which was covered by wheels that turned and pressed down the soil upon the seed. The check rower followed; it was a simple implement, consisting of a wire chain or knotted rope stretching across the field and anchored at both ends. This passed through the machine as it was driven across the field and dropped some grains of corn every time the knot passed through a slot in the machine. It was only necessary to drive backward and forward all day long until the acres were planted, and then the corn could be cultivated in both directions. Subsequently, numerous check-row planters for corn have been invented with and without fertilizer adjustments, so that several rows of corn may be planted at the same time in places at regular distances apart, permitting cultivation in both directions.

Cultivators.—Cultivators have been the subject of several thousands of patents. The original cultivation of corn and other crops planted in rows was by means of the hoe, but in the course of time a plow was used to loosen the earth and to suppress weeds and grass, being drawn twice between the rows and turning the soil against one or the other. Next a tooth harrow was employed, and this was drawn one way between the rows, and afterward a cultivator with small double plowshares was used. Then followed the double-shovel cultivator, cutting deep or shallow, as desired, and turning the earth toward two opposite rows at the same time. The implement is now variously made, but it has reduced the economy of cultivation apparently to a minimum; the farmer may now ride while the cultivator is doing its work. He cultivates the rows of his crop in both directions, and the use of the hoe has been nearly, if not entirely, discontinued throughout large agricultural areas.

Harrows.—Much attention also has been devoted to the invention of implements for harrowing and pulverizing the soil. The farmer no longer drives a brush harrow over his field as of yore, nor does he need to use a tooth harrow, but he has at his command disk harrows, screw pulverizers, smoothing harrows, spring-tooth harrows, and harrows combined with plows and seeders.

Corn Husker.—The mechanical corn husker is a machine of recent invention. Previously the husking of corn was done only by hand, and a peg strapped to the hand was often used for opening the husks; but there is now a machine that husks the corn and at the same time cuts the husks, stalks, and blades into feed, the motive power being steam.

Corn Harvester.—Again, we have the recent corn-harvesting machine drawn by horses that cuts the cornstalks and binds them into bundles at the same time.

Cornshellers.—The steam cornsheller caused a remarkable change in the time and expense of the shelling of corn. In the olden time corn was shelled by hand, a frying-pan handle or shovel being used, the ears of corn being scraped against it, or perhaps the cob of one ear was used to shell the corn from another. Then came the first machine for shelling corn, a cylinder turned by a crank, by which a man might shell about 40 bushels in a day. Thousands of patents have been issued for cornshellers, and the culmination of them is the steam power or horse power cornsheller, which will shell a bushel a minute, carry off the cobs to a pile or into a wagon, and deliver the corn into sacks or wagons.

Seeders.—From the time when wheat was first sown, up to a comparatively recent period, the only method of sowing it was to throw it into the air by the hand. In this way it is impossible to sow evenly, especially if the wind blows with considerable force; and if clover seed is to be sown, the ground must be gone over a second time, while a third time is required if fertilizer is to be distributed. Then, when the harrow comes some of the grains are buried too deeply and some are not covered with earth enough. But not so many years ago inventors set to work to construct mechanical seeders, and the result is an almost complete abandonment of broadcast sowing by hand and the substitution of such seeders. They sow all kinds of grain and seeds at once, with fertilizer if required, and they harrow at the same time. They made the crop more certain. It is the general opinion that the wheat crop is increased one-eighth or more by the use of the mechanical seeders, especially in the case of winter wheat.

Mowers and Reapers.—In 1794 a Scotchman invented what was described as a most marvelous and wonderful machine for cutting grain, doing as much in one day as seven men could do with the sickle. This marvelous machine was only the cradle. The reaper followed, and the first patent for one issued in this country was given to Hussey in 1833. McCormick took out his first patent in 1834, although he had constructed and tested a machine in Virginia in 1831 with some success; but the world heard little of reaping machines until 1845, when 150 of them were built at Cincinnati; by 1846 fully 300 had been built. There was a general

* The development of transportation facilities in the United States is the subject of another article in this Yearbook.—ED.

† "A Century of Connecticut Agriculture," by Prof. William H. Brewer, twenty-eighth annual report of the secretary of the Connecticut Board of Agriculture, 1894, p. 49.

‡ Eighty Years' Progress of the United States, p. 27.

§ Arguments before the Committee on Patents of the Senate and House of Representatives, 1878, p. 272.

trial of mowers and reapers at Geneva, N. Y., in 1852. Nine machines contested, for other inventors had taken out patents. Nineteen years had passed since the first patent had been issued. Out of the nine machines exhibited not one could start in the grain without backing to get up speed. There was a heavy side draft, the machines were clumsy, and they could not turn easily.

By 1855 about 10,000 mowers and reapers had been built by different makers, nearly all being one-wheeled machines. There was an exhibition of reapers at the French exposition in 1855, in which there was one English, one French, and one American. The French machine did its allotted work in 72 minutes, the English in 66, and the American in 22.

Two years later, in 1857, there was a trial at Syracuse, N. Y., at which nineteen machines contested. Of these, all except three started in the grain without backing to get up speed. There was a trial at Auburn, N. Y., in 1866, at which forty-four different machines were entered, and of these, forty-two did their work in a satisfactory manner.

The mower and reaper combined cut the grain and left it on the ground bunched up in proper size for a sheaf, subsequently to be bound by hand. The harvester was supposed to be an improvement upon this, because it had a place for one or two men to ride to bind the grain as fast as it was cut; but the self-binder went beyond that and by means of a mechanical attachment did the binding without the aid of human labor. It was not until 1870 that the self-binder was a mechanical success; but that was not the end of invention for constructing machines to harvest wheat.

It remained for the ingenuity of man to construct a combined reaper and thrasher, with which it is necessary only to drive across the wheat field in order to obtain the grain ready for transportation to the elevator or elsewhere.

Cotton Gin.—Without the cotton gin it would be practically impossible to raise and market the cotton crop of this country, which now commonly amounts to 10,000,000 bales and more annually. Before Whitney's invention it is said that the labor of one person was required for about ten hours to pick the seeds from 1½ pounds of cotton lint. At the present time one machine will gin from 1,500 to 7,500 pounds of lint in the same time, the quantity varying according to the size and power of the gin.

(To be continued.)

[Continued from SUPPLEMENT, No. 1312, page 21030.]

THE OPTICS OF TRICHROMATIC PHOTOGRAPHY.*

II.

AFTER Du Hauron applied for his patent, but before there had been any publication of his method, Charles Cros, of Paris, proposed a system of trichromatic photography in a communication which appeared in Les Mondes, February 25, 1868, and it is stated that he had described the same system two years before in a sealed mémoire deposited in the Academy of Sciences.

Cros also proposed both positive and negative synthesis. He at first appeared to accept red, yellow, and blue as the primary colors of light, and described methods of positive synthesis by triple lantern projection, by application of the principle of the zoetrope, by an arrangement of transparent reflectors, and by a prismatic device, employing in each case photographic positives from the original negatives, and red, yellow, and blue lights. For the production of color prints he said the same negatives could be used, and the prints made in the "antichromatic" colors, "green, violet, and orange." Cros here clearly avoided the mistake of Collen and Du Hauron of trying to record two primaries in each printing negative, and it is remarkable that his printing colors, "green" and violet" (purple), are just as near to the true printing colors, *minus* red, and *minus* green, as are true blue, and red. Afterward, in the same article, he expressed the opinion that it might be better to make the negative by "green, orange, and violet" rays, and the prints in their "antichromatic" colors, "red, blue, and yellow."

Cros did not recognize red, green, and blue as the correct triad of primaries, nor that the "blue," and "red," or "green," and "violet," printing colors should be green-blue and crimson-red. There was no suggestion of anything so definite as analysis by color-curve screens to be followed by positive synthesis with pure colors.

Cros' suggestions were generally of a somewhat speculative character, and he amusingly disclaimed any wish to submit himself to the "painful" labor which he could foresee would be necessary to arrive at a practical realization of color photography by such a system. He said he preferred to show the way, and to claim the credit after somebody else had done all the hard work. By this decision he proved himself to be, from a material point of view, one of the wisest men who ever attacked this problem, and, this being his position, he could afford to be somewhat vague—the more so the better; but some of his suggestions now appear wonderfully acute and prophetic, and are worthy of special notice.

For instance, Clerk-Maxwell and Collen both recognized the necessity for color-sensitive photographic plates in order to practically realize their ideas, and Du Hauron was content to give enormously prolonged exposures so as to utilize the extremely feeble color sensitiveness of the ordinary photographic plates of that time. Cros, who also recognized this difficulty, pointed out that a photographic plate can only be acted upon by light which it absorbs, and said he thought it might be possible to make the plates color-sensitive by incorporating suitable dyestuffs. In this publication he clearly anticipated the "principle" of "optical sensitizers," as it was afterward stated by Dr. Vogel, and, although he appears to have thought that the mere coloration of the film might serve to make the plates color-sensitive, it is a remarkable fact that he said a search should be made among a class of dyestuffs, some of which actually do confer color sensitiveness to bromide of silver plates!

Cros not only anticipated Du Hauron in the matter of actual publication, but was quite as fertile in original suggestions, and was, I think, more of a scientist, if less of a mechanic, than his rival.

I believe the names of Clerk-Maxwell Harry Collen, Baron Ransonnet, Louis Ducos du Hauron, and Charles Cros complete the list of independent inventors of trichromatic photography.

Although Clerk-Maxwell was the first, there is in the original publications of Collen, Du Hauron, and Cros, internal evidence of independent conception of the idea.

Assuming that I have correctly set forth the essential conditions of success in trichromatic photography, and that I have fairly represented the publications of the original inventors, propositions by which I am prepared to stand or fall (I have recently studied the publications of Du Hauron and Cros most carefully), it follows that, brilliant as were the conceptions of these inventors, they failed to recognize requirements essential to success; and I do not hesitate to say that this is the true explanation of the discredit into which this idea had fallen after many attempts to reduce the methods to practice.

Du Hauron and Cros continued to try to perfect and exploit their ideas, but made very little real progress that I have been able to discover, except that Du Hauron made distinct improvements in cameras for making the color records, and Cros in 1879 (The Review of Games, Art and Sport, February 15, p. 221) had definitely settled upon "orange, green and violet," as the "primary" colors of light, and stated that the prints should be made in pigments which suppress the respective primaries. After nearly twenty years (from the dates of Du Hauron and Cros' publications), although all the materials requisite to experimental success had long been at hand, the principle had not been confirmed by a single really successful result, and was apparently universally discredited.

Meanwhile Dr. H. W. Vogel, in 1885, stated as a "new principle," that the negatives should be made by the same spectrum rays that are absorbed by the printing colors, and in the same proportions—in other words, that the "optical sensitizers," or colors spectroscopically identical with them, should be the printing colors. This was only another way of stating Cros' principle of printing in colors "antichromatic" or complementary to those which produced the negatives.

Dr. Vogel's statement of this "principle" disclosed no recognition of the relation which the negatives or printing colors must bear to the physiological analysis of the spectrum colors, thus missing the most vital point; and it is under no circumstances a true principle in trichromatic photography, but at best involves precisely the same error as the theory that positive synthesis should be effected by screens which transmit all the various rays which have acted to produce the respective photographic "color-curve" records. I hope I have made it clear that the true function of the printing colors is to subtract most efficiently (specifically) from ordinary white light the visual impression belonging to the respective color elements, and that this is not effected by colors complementary to the correct photographic action. Notwithstanding the errors involved in Dr. Vogel's theory as applied to the trichromatic process (he also proposed a more complex analysis), the weight of his authority caused it to be generally accepted in Europe, and it is still a stumbling-block for many experimenters.

It was the acceptance of this theory that made Von Hübl, in 1888, declare that the Young-Helmholtz color theory is not a suitable basis for a theory of three-color printing, and that he could not see in what way it had indicated to me the correct printing colors.* Having no theory to guide him but Vogel's, Von Hübl worked out the details of a method which, assuming that he actually worked to his diagrams (see The Amateur Photographer, January 19, 1884, p. 47), would reproduce the spectrum itself as three broad bands of equal and much diluted color, with only very narrow spaces of blending between.

Thus does false theory lead to error; and yet this method, which would completely break down upon the spectrum itself, is described in one of the technical journals, nearly six years after the publication of the principle of color curve analysis, as "enriching our literature on this subject with the clearest exposition of the theory yet propounded!"

Dr. F. Stolze, of Berlin, published a series of articles treating of the theory of trichromatic photography, the date of which I cannot give, having never seen them in the original. Translations appeared in Anthony's Photographic Bulletin in September, October, and November, 1888, but it has been stated that the original publications appeared some years before. Dr. Stolze was probably the first to mention the Young-Helmholtz theory of color vision in connection with this subject, and to point out that the most that could be expected of a trichromatic process was that it should more or less perfectly counterfeit most of the spectrum hues to the eye by color mixtures physically different from the original colors.

Dr. Stolze's writings were not reproduced in English, and did not come under my observation until long after I had published similar observations, which he then claimed, very justly I have no doubt, to have in some measure anticipated. He treated of the subject only as applying to the production of color prints, and did not formulate a definite principle, or recognize the practical bearing of the Maxwell measurements of spectrum color mixtures, and his conclusions were distinctly antagonistic to hopes of practical success. My own experiments commenced early in the year 1878, and before the end of that year I had at hand all the material means requisite to success, such as perfect color-sensitive plates, control of the absorption of color screens, a method of producing half-tone process blocks for carrying out the idea in typographic printing, etc. Nevertheless, my results, even in lantern projections, were crude and discouraging. My theoretical knowledge of the subject was inadequate to discover the sources of error. Like Du Hauron, I gradually improved my results by sheer experience, but I am more perfectly convinced that complete success could never have been achieved by such a process of trial and error.

I became convinced that a quantitative analysis of the various spectrum hues in terms of three spectrum colors must form the basis of a successful method, and stated this principle and the method of its application somewhat clumsily in a paper read before the Franklin Institute in February, 1888.*

My analysis was, however, imperfect, and it was only after some reference to Maxwell's work in spectrum color analysis which appeared in Rood's "Modern Chromatics" came under my observation, that I was able to perfect my method, and to clearly and perfectly enunciate the principle of color-curve analysis and pure-color synthesis, which I did in a paper read before the Franklin Institute in November of the same year.†

The application of this principle resulted in the accurate reproduction to the eye of the colors of the objects photographed—something which I then believed, and still believe, had never before been accomplished, and which probably never would have been accomplished by a trichromatic process without recognition of this principle.

I think I am correct in saying that the soundness of my theoretical exposition of the subject was soon recognized by Dr. Stolze, Victor Schumann, and Sir W. Abney, but that it was actively discredited, though without argument, by almost everybody who had previously become identified with the subject in the public mind.

Apparently unanimous condemnation by "practical experts" had the effect of persuading most people that my method must be wrong and my results tricked, and the wheels of progress continued to be clogged by voluminous writings which served chiefly as a negative means of discrediting an important truth.

I mention these facts in explanation of the aggressiveness which I have shown in my fight for recognition of this principle, and which has often been mistaken for a mere ebullition of egotism. I submit that, as a conscientious teacher, I could not do otherwise than maintain that by the application of this principle the problem of recording and reproducing colors by photographic analysis and optical synthesis was finally solved.

This course on my part has been all the more necessary because in some pretentious treatises, such as that of Alcide Ducos du Hauron, published in Paris as recently as in 1897, the principle of color-curve analysis, to be followed by pure color synthesis, is not even stated, and the principle of analysis is no more definitely stated than that the negatives should be made by "orange," "green," and "violet" light; and in the "melano-chromoscope," credited to Louis Ducos du Hauron, and only recently manufactured for sale, the photographs are supposed to be made through the same screens that are used for synthesis. Such loose methods may serve as playthings, but they no more represent scientific trichromatic photography than a child's use of a sixpenny prism represents the science of spectrum analysis.

Since this part of my lecture was in manuscript I have had the great pleasure of perusing a treatise on trichromatic photography by an English author, who has not only recognized the principle of color-curve analysis and pure color synthesis, but has presented the subject in a most admirable manner. No doubt many who have found my own essays too concise and dogmatic in style to appeal to them successfully will find Mr. Tallent's further arguments and illustrations sufficiently convincing. It needed only the publication of such a treatise as this to put a period to my aggressiveness in a fight which has become distasteful to me.

Owing to the great number of factors in this solution of the problem of color photography, a very great amount of work remained to be done in order to realize the conditions of successful every-day practice and general application.

Without special cameras for making the color records automatically and special devices for accomplishing the synthesis, the method could never have much practical value. Both Du Hauron and Cros recognized this fact, and the former especially sought to provide for these requirements, and made some brilliant suggestions, without, however, meeting all the practical requirements.

The principal optical devices employed in carrying out the process in its ordinary forms are special cameras, triple lanterns, and photo-chromoscopes. Within the legitimate limits of this lecture I cannot describe these in detail, but will mention their characteristic features, and will give such references as will enable anybody to verify my statements and study the more intricate details.

A feature common to most of the cameras and photo-chromoscopes which have been proposed is the use of transparent reflectors, so disposed as to form three images with one objective or one viewpoint when used as a camera, or to superpose the three photographic images upon the retina when used as a photo-chromoscope. Both Du Hauron and Cros proposed the use of plane parallel clear glasses for this purpose. Du Hauron went further; recognizing that the two separated reflecting surfaces would double the outline of the images and produce confusion unless the positive images were optically at an infinite distance, he proposed the introduction, between the reflectors and the image, of convex lenses at exactly their focal distance from the images.

This arrangement, as originally conceived, was optically efficient as a photo-chromoscope, with the three images situate on different planes. In 1876 (British Patent No. 2,873, July 22), he designed a camera involving the application of this principle, in which the three convex lenses were used as image-forming objectives, with a separate adjustable diaphragm for each lens, in order to equalize the exposures, and the use of convex lenses in front of the camera to parallelize the rays for near objects. As the rays can only be parallelized for one plane at a time, objects situate in all other planes would still be doubled in outline.

In a combined camera and photo-chromoscope the construction of which was first published in 1887,

* The Third Trail Taylor Memorial Lecture. By F. E. Ives. Read before the Photographic Society of Great Britain.—From Br. Jour. of Photography.

* Process Photogram, April, 1888, p. 53.

* Journal of the Franklin Institute, Philadelphia, May, 1888.

† Journal of the Franklin Institute, Philadelphia, January, 1888, p. 58.

and which has been named the "melano-chromoscope," the plane parallel glasses and convex lenses are so disposed as to bring the three images all on one plane;* but this construction involves the application of new ideas which I patented in 1884,† and a description of it is therefore not altogether in place at this point in my lecture. Waiving this objection to such an order of presentation, I will point out some of the defects of this instrument.

In the first place, it is optically imperfect except when used under certain well-defined conditions, because the convex lenses are at three different distances from the view point. The effect of this is to introduce different degrees of barrel shaped distortion in the three images, when used as a camera; and while this does not prevent the instrument from superposing the same images in synthesis, provided that they are images of distant objects, it is incapable of perfectly superposing to the eye three equal images, and it cannot be used successfully for photographing near objects, because, the image-forming lenses being at different distances from the object, the three images will not focus alike either as to definition or size.

Any photo-chromoscopic device which is designed for analysis and synthesis with the same color screens, like this one, I would class as a toy. Made as two separate instruments, one adjusted for photography and the other for synthesis, it could be made to meet scientific requirements for the reproduction of landscapes in miniature, but the difficulty and cost of obtaining clear glass reflectors with perfectly plane-parallel surfaces, the fact that the images are not available for synthesis by other methods because not identical in perspective, the impossibility of focusing near objects on all three sections of the plate at once, the impossibility of diaphragming separately for the three lenses, and the small angle which the images subtend to the eye, are all serious defects. Another defect in the instrument as now constructed, due to the fact that the clear glass reflectors disposed at 45 deg. angle to the axial ray have polarizing properties, I shall describe later, also a defect of illumination of the image due to the relation of incidence and reflection with glass mirrors.

Charles Cros suggested positive synthesis by persistence of vision with a device constructed upon the principle of the zoetrope, and his brother, A. H. Cros, in 1889,‡ patented a device for carrying out this idea. Cros' instrument was of the three-step form characteristic of photo-chromoscope, constructed with two transparent and one silvered reflector, but the images were blended by means of a rapidly revolving wheel having four plane silvered and two clear open sectors, in combination with another plane silvered mirror occupying parallel planes disposed at 45 deg. to the axial ray, and the wheel revolved by pulling a string wound upon its axle. This device was intended to be used also as a camera for making the three negatives through the same color screens.

(To be continued.)

A MODEL SYSTEM OF WATER-WORKS.

By F. O. Jones, Ex-Chief Engineer.

It is surprising how little common sense and regard for health considerations are manifested in the construction of some water systems. The storage reservoir, from which, in nine cases out of ten, the water is conveyed direct to the consumer, is frequently formed by throwing a dam across a small valley. Heavy rains wash various kinds of filth into it from the hillsides, and in a short time it is surrounded with aquatic weeds and infested with water-vermin. An occasional cleaning away may ease the conscience of the authorities, but the practical effect is little more than a stirring up of the contamination.

That cities and villages sometimes suffer an epidemic of typhoid fever is not remarkable; rather, it is remarkable that the epidemic does not become a permanent one. If it is unusually severe, the effect is much the same as that of a stone thrown at a hornet's nest—there is a great hubbub for a time. There may be resolutions calling for an investigation of the water supply, but the ultimate result is generally represented by a zero mark.

There is little excuse for such a condition of things —unless ignorance can be called an excuse—for the first cost of a properly constructed system is only slightly greater than that of an inferior one, and the eventual cost decidedly less. Such a system, eminently suited both for domestic purposes and fire protection, I propose to describe in this article. My statements, however, chiefly apply to what is known as the "gravity system"—the only kind within reach of small villages.

It is assumed that the supply of water comes from springs—and it is advisable to secure springs if possible, even though the outlay is thereby considerably increased. Each spring should be carefully dug out and walled up, the wall being laid with cement to exclude earth-worms and other vermin. For the same reason, the coverings should be constructed of grooved and seasoned oak plank and bedded in the mortar. A small trap door, which it would be well to keep fastened with a good padlock, will permit of an easy examination of the spring at any desired time.

The water of the springs, if their relative locations permit, should be conveyed to a common receptacle through glazed tile, galvanized iron or cast iron pipe. Either one of the latter two would be preferable if soft, marshy ground is encountered. An excellent plan is to run a 4-inch pipe from the largest spring, and into this the flow of the other springs can be conducted at convenient points. If the entire supply comes from one spring, the problem is, of course, greatly simplified.

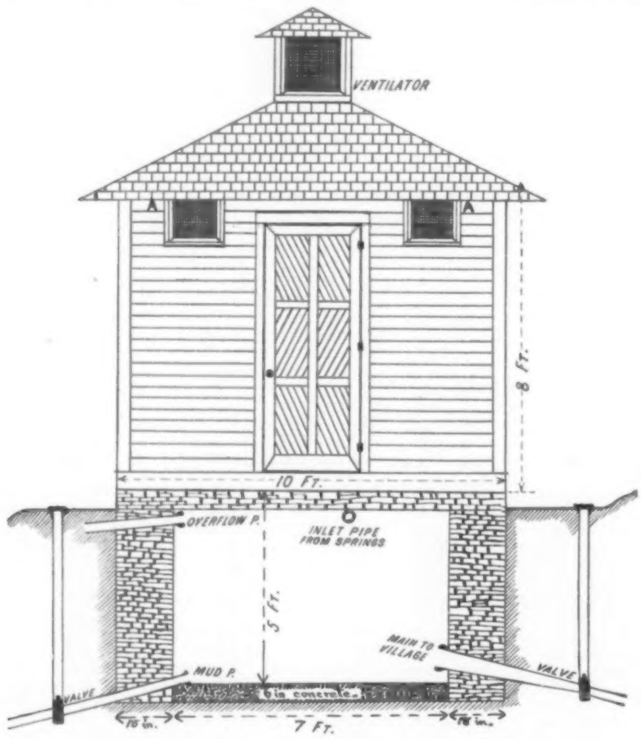
The receptacle for receiving the water of the springs is called receiving or intermediate reservoir or spring house. Since it is not designed for storage purposes, an internal diameter ranging from 6 to 10 feet will suffice for any system. The bottom, which should be formed by a layer of concrete on well tamped earth, must be at least 4 feet below the surface of the ground. Cement-laid walls of stone, which is generally the cheapest and most easily procurable building material, may then be carried up to the roof—preferably a metal one. These walls should be 2 feet thick until a point well above ground is reached, when the thickness may be reduced 6 or 8 inches; or, they may be discontinued entirely at this point and a superstructure of wood erected. This superstructure should not be less than 6 feet in height, making the total inside height from the bottom to the plate about 12 feet. Besides a door for convenient access, there should be, immediately under the roof, several large ventilating openings covered with wire screens having a mesh sufficiently fine to exclude flies and other small insects. A waste or mud pipe leading from a slight depression on one side will admit of a thorough cleaning being given the reservoir without much trouble. The valve in this pipe should be so located that it may be operated from the outside. Two other valves on the outside are also necessary—one in the inlet pipe and one in the main pipe. By means of the former the water may be shut off from the reservoir in case repairs are needed at any of the springs, and the latter will perform a similar office for the system when it becomes necessary to "clean house" at the reservoir.

The advantage of the receiving or intermediate reservoir is twofold. First, it collects any small amount of sediment which may come from the springs and prevents the same from being carried into the mains; and, second, by closing the valve on the main pipe, a water head of a few feet is obtained which is sometimes very useful in driving air out of the mains and for flushing them of the dirt left behind by the workmen. It is, in effect, a filtering plant; and with the end of the main pipe raised a few inches above the bottom, a pure water supply is assured as far as it lies in human power to do so.

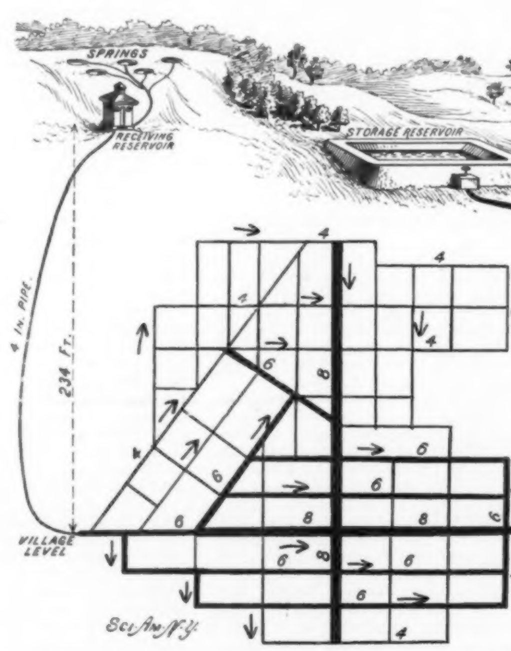
The size of the pipe leading from the receiving reservoir to the village should be determined solely from the amount of water which it may be required to deliver. A 4-inch pipe will carry the water from half a dozen large springs and supply a village of considerable size, especially if it terminates at the receiving reservoir in an expander or V-shaped length in order to lessen the friction. When the outskirts are reached, this pipe connects with a main suited to the size and requirements of the village.

From the village a large main should lead up to the storage reservoir. Ordinarily, this will be located on the side of the village opposite the springs, but it may be located on the same side. The location is of minor importance so long as the water must first pass through the village in order to reach it. By this arrangement a constant movement of the water in the mains is insured, even though not a single tap is opened. For ordinary domestic purposes, the water comes direct from the springs, cool and fresh. If more is required than the springs furnish, as in case of a fire, the excess is drawn from the storage reservoir.

In the construction of the storage reservoir, the purity of the water should be carefully preserved. For a lining, there is nothing equal to concrete with a facing of cement, provided the sides are sufficiently firm and strong to prevent settling. The cost, however, is considerable. An excellent substitute is pure clay, which is not infrequently found in excavating the reservoir itself. This should be well puddled on to a depth of 6 inches and a layer of stone placed close together bedded in while it is yet soft. The layer of stone will prevent roiling of the water by the action of the waves and keep the clay from cracking or baking whenever the water level happens to fall below its normal height. All surface washings must, of course, be carefully excluded.



RECEIVING RESERVOIR, SHOWING SUPERSTRUCTURE.



OUTLINE OF MODEL SYSTEM OF WATERWORKS, SHOWING RELATIVE POSITION OF RESERVOIRS, FLOW OF WATER, AND SIZE OF MAINS.

In deciding upon the capacity of the reservoir, not only must the size of the village and the amount of water furnished by the springs in a dry season be taken into consideration, but also future needs. Moreover, it is seldom that any two villages of the same population will use even approximately the same amount of water. The conditions and needs are so dissimilar as to defy comparison. As a rule, manufacturing towns require the greatest per capita supply. In any case, it is best to provide for a liberal margin, hence the question of economy should not be allowed to assume undue importance. Ordinarily, a capacity of 600,000 gallons will be amply sufficient for the present and future needs of a village of 1,500 inhabitants. This is at least a twelve days' supply, exclusive of the springs, and will fill a reservoir 100 feet square to a depth of 8 feet. For fire purposes, it is more than an abundance, as half a dozen streams will not perceptibly lower it. The ratio of storage capacity, however, should increase faster than the ratio of population; hence, for a village of 5,000 inhabitants a reservoir holding 5,000,000 gallons is none too large.

The elevation of the reservoir above the village is a point which should be well considered. Perhaps a portion of the village lies upon a hillside, in which case a greater elevation must be sought than would otherwise be necessary. However, if the elevation is too great, the pressure interferes with the domestic part of the service. A sudden closing of a tap produces a very destructive "water hammer," and only the best grades of lawn hose will last for more than a single season. For general purposes, an elevation of 200 feet is about right. This means a pressure of 87 pounds to the square inch, and three men will have all they want to do to handle one fire stream. Fifty feet may be deducted for elevated portions of the village and still leave a fair working pressure.

The size of the mains depends upon the requirements which they must meet. A 4-inch main is large enough for the outlying resident portion. For the more important streets a 6-inch main should be laid, while

* "La Triplice Photographique des Couleurs et l'Imprimerie," Paris, 1897, p. 357.

† That he did not originally contemplate a one-plate arrangement is proved by the wording of his specification of 1876, p. 15, lines 48-54.

‡ British Patent No. 9,012, May 30, 1889.

for the business streets an 8-inch main is none too large. This for a small village. The larger the place, the larger, of course, the primary mains. I would recommend nothing less than an 8-inch main from the storage reservoir to the center of the village, in even the smallest systems. One factor in determining the size of the mains is the proposed pressure. If a low pressure only is possible, the size of the mains along streets where good fire protection is desired should be slightly increased. A 6-inch main under a pressure of 100 pounds will afford as many serviceable fire streams as will an 8-inch main under a pressure two-thirds as great.

It is usual to locate hydrants upon convenient corners. In the business portion of a town, however, I would urge that they be placed at intervals of approximately 100 feet and upon alternating sides of the street. Not only are hydrants cheaper than hose, but the time thereby saved when several lines are required is often a matter of thousands of dollars. The value of short lines of hose is still further enhanced by the fact that a stream passed through a line five hundred feet long loses one-third of its force.

In this article, details have, of course, mainly been omitted, as they can more properly be supplied by an engineer who has examined the proposed location. The principal ideas are to keep the water in its first purity and in constant circulation. With such a system as here described installed, one may draw and drink a glass of water in the darkness without the possibility that perhaps he swallowed some minute specimen of animal life.

THE HEART OF ROUEN.

THIS drawing, which was sketched upon the spot a few months back, is taken from a window of a house upon the quay. It represents the most ancient part of that remarkably interesting city as it is at present (factory chimneys, iron spire, and all). The foreground shows the various old streets which form a kind of net-work of ancient houses and buildings between the Halles and the Rue Grand pont. The houses are interesting examples of timber construction coated all over with slate very ornamentally treated. Viollet le Duc, in his "Dictionnaire," gives examples, under the heading "Ardoise," of this form of slate-casing, so common in this part of Rouen. It is somewhat curious that, although these houses have highly-ornamental gables, towers, and richly-carved corbels, no decoration of any kind is to be found on the chimneys, which are perfectly plain. The streets, etc., shown in this view are the Rue du Bac, the Rue des Halles, Rue de la Savonnerie, Rue de l'Epicerie, and the Rue Potard. Part of the buildings of the Halles are shown to the extreme left, but the curious Renaissance building called "Haute Vieille Tour" is not visible from this point of view. Andrea Cook, in his charming "Story of Rouen," points out a great peculiarity of this part of the city. The streets all run *up* to the quay and not down to it, and as the Cathedral is on a hill, the whole district forms a valley, and it seems as if it must formerly have been covered with water and the river banked up at some time; or was there a *second* island between the original shore and the Ile Lacroix? This sinking of the land is distinctly visible in our view, and throws into prominence the Cathedral and St. Maclou, whereas St. Ouen, which is the loftiest church of the three, being below the brow of the hill and on the opposite bank of the Robec, is less conspicuous. That eccentric little river almost turns a right angle under the Rue d'Amiens, and flows at the back of the Rue Damiette, after which it disappears. All this part of the city, when seen from a height, looks a bewildering maze of lanes and houses, which, together with the three magnificent churches, form a picturesque group such as is scarcely to be equaled anywhere else in Europe. Not only is the general view so fine, but when we examine it in detail we shall find such streets and houses as delighted Prout and Coney. The Rue de l'Epicerie, the Rue du Bac, the Rue de la Savonnerie, the Rue Damiette, and "Eau de Robec" are specially rich in old carved and slate-fronted houses. The tall slate-covered towers are very singular features in the Rouen houses. One does not notice them so much in passing along the streets, because they are generally in the courts at the back of the houses.

Alas! what is to become of all this maze of picturesque but dangerous and insanitary dwellings—this "dream for the artist," but nightmare to the unfortunate Town Council of Rouen? The great danger is fire, the less "demolition"!

When, however, that demolition takes place we do trust that it will not be carried out with that total disregard of everything ancient which characterized the construction of the Rue de la République and some other new thoroughfares in Rouen; and one is glad to notice that in the rebuilding of the Hotel of the Crescent, "Cour des Comptes" (an eighteenth century structure), the old sixteenth century doorway and beautiful Early Renaissance cloister have been saved, which gives one a hope of better things for the future.

The last of the old timber houses touching the Cathedral buildings is coming down; it is in St. Romain Street, and is interesting. We cannot, however, blame the Town Council for removing these houses attached to the churches, as the danger from fire and the insanitary conditions created by such buildings are too serious to be neglected, even for the cause of picturesqueness.—H. W. Brewer, in The Builder.

THE HEART OF ROUEN, FRANCE.

SCIENTIFIC REWARDS IN FRANCE.

EACH year the Paris Academy of Sciences awards prizes of money or in the form of medals to the authors of memoirs that are adjudged to be of superior excellence and fitted materially to advance our knowledge of some branch of pure or applied science, says The New York Sun. A few of the prizes are established by government, but most of them are paid from the income of funds bequeathed by private persons. The Cuvier prize of 640 francs and the Lalande medal of 460 francs are examples of awards that have a value above the mere money reward, because, in the first place, they were founded by the great men whose names they bear, and in the second, because they have been bestowed upon a long line of illustrious men of science into whose company the new beneficiary is introduced by the award. The prizes are awarded by committees of the Academy, who study the memoirs presented and report in detail upon their special points of excellence. It oftens happens that no award is made in a particular year because no memoir has been received of sufficient merit; or it may seem best to divide the prize into several parts, to be given to several contestants. The judges often make honorable mention of papers not quite worthy of a prize, but yet presenting special points of merit. The effect of an annual account of stock, taken by experts, of the science of the country, and in fact of the science of the world—for most of the prizes can be and often are bestowed upon foreigners—is very marked, and in many respects it is very admirable.

Science should be and is pursued by its votaries for its own sake, and more or less austerely. No man who keeps his eyes fixed on honors and medals can be continuously successful in the field of scientific research, but no man, however austere, can fail to be encouraged and pleased by a formal recognition of his work made by his equals or superiors, and signalized by the bestowal of awards bearing great names like those of Cuvier, Lalande, Poncelet, etc. Such prizes are especially useful in their effect upon the younger men just entering the scientific field. From a list of the prizes bestowed in the year 1900 it appears that the Paris Academy of Sciences disposes of fifty prizes amounting in money value to about $48,823. The separate branches of science have prizes as follows:

In geometry there are four prizes of 3,000, 3,000, 1,000 and 2,000 francs respectively, or $1,800 in all.

In mechanics there are three prizes of 6,000, 700 and 2,500 francs respectively, or $1,840 in all.

In astronomy there are four prizes of 540, 1,500 and 460 francs and a medal of gold, say $2,600 in all.

In statistics there is one prize of 500 francs or $100.

In chemistry there is one prize of 10,000 francs or $2,000.

In botany there are four prizes of 1,600, 1,500, 1,000 and 500 francs respectively, or $920 in all.

In anatomy and zoology there are three prizes of 200, 975 and 1,200 francs respectively, or $475 in all.

In medicine and surgery there are ten prizes of 7,500, 2,000, 100,000, 1,000, 3,400, 1,400, 10,000 10,000, 1,800 and 1,000 francs respectively, or $27,620 in all.

In physiology there are four prizes of 750, 1,400, 1,400 and 890 francs respectively, or $888 in all.

In physical geography there is one prize of 2,500 francs, or $500. Besides the prizes offered for specific researches in one particular branch of science there are general prizes that are awarded for excellence in any subject of science. There are fourteen such prizes of 3,000, 1,500, 4,000, 4,000, 1,100, 4,000, 1,000, 3,500, 3,000, 5,000, 1,300, 3,000, 3,000 and 2,500 francs or $7,980 in all, and finally the prize offered to the head of the graduating class of the Ecole Polytechnique of a complete edition of the works of Laplace.

Rewards of like nature are given by other academies of science in Europe, and the National Academy of Sciences and other scientific bodies in America bestow a few prizes of the sort in our own country.

ELECTRIC TRAMWAYS AND ASPHALT PAVEMENTS.

VARIOUS attempts have been made in Germany to devise a means whereby the destructive influence exerted by the passage of heavy electric tram-cars upon asphalt pavements may be counteracted. Hitherto, says a German trade review, these endeavors have been without definite result, but much has been said lately in praise of a system which is shortly to be subjected to a practical test in Berlin. Contrary to ordinary practice, in which the tram lines are laid immediately upon a foundation of concrete, further resting in direct contact with the superimposed asphalt, the new method consists in laying the rails upon a bed of coarse gravel and running a line of hardwood blocks along either side. Experience has taught that ordinary pavements with gravel and stone foundations in place of concrete offer the greatest resistance to the influence of electric

cars. It is assumed that the gravel or stone allows the rails more play, which is advantageous in that, despite great care in their manufacture, it is impossible to ensure exact uniformity with the gage of the cars. The new method is also relied upon to reduce the noise caused by the cars running over the lines.

RETIREMENT OF REAR-ADMIRAL PHILIP HICHBORN, U. S. N.

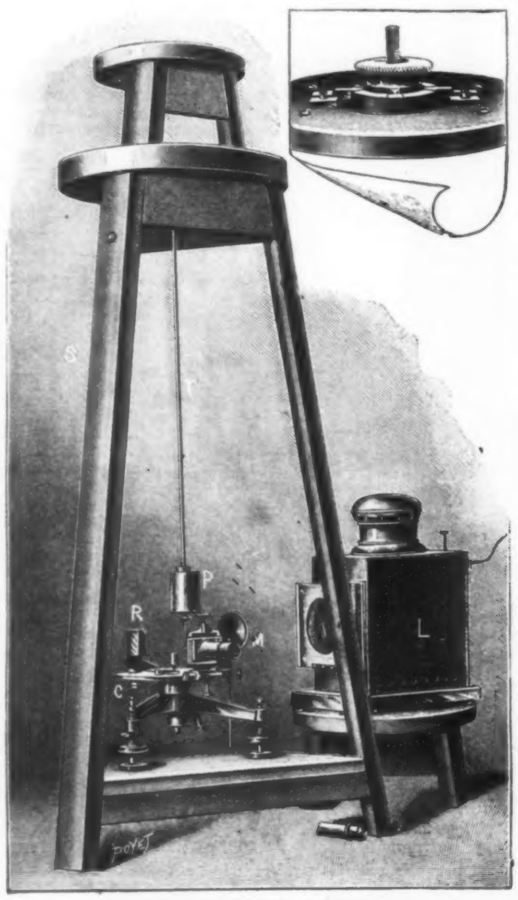
SIXTY-TWO years prior to the 4th of March, 1901, the date on which he retires on account of age limit, Rear Admiral Hichborn, Chief of the Bureau of Construction and Repair, was born in Charlestown, Mass., he being the second son born to Philip Hichborn, a highly respected citizen of Boston and vicinity. Young Hichborn was educated in the public schools of Boston, and graduated from the high school of that city. For a few months after finishing school he acted as assistant secretary to Admiral F. H. Gregory, the commandant of the Boston navy yard, and then became indentured to the government as shipwright apprentice in the same yard, under the tuition of Melvin Simmons, master shipwright. During this five years of apprenticeship he entered the night class at French's Mercantile Agency, from which he graduated in 1859. After receiving his certificate of apprenticeship, and in recognition of his merit, the Secretary of the Navy, Isaac Toucy, upon recommendation of Admiral Gregory, ordered that Hichborn receive a course of theoretical training in ship design and calculations.

A mutual desire to be associated with each other led Mr. Hichborn from the Atlantic to the Pacific coast, where his former instructor, Melvin Simmons, having been appointed a naval constructor, was stationed. In August, 1861, having obtained a position as carpenter of the clipper ship "Dashing Wave," he set sail from Boston for the Golden Gate. Entering the navy yard, Mare Island, as a journeyman shipwright promotion came rapidly; a vacancy occurring in the position of timber inspector was the first step in his advancement; then to draughtsman; quarterman shipwright, and on September 30, 1862, to the very responsible position of master shipwright. In May, 1869, he passed a severe examination and was duly appointed on June 26, 1869, an assistant naval constructor, U. S. N., with the rank of lieutenant. In 1870, after ten years' life on the Pacific coast, he was detached from duty at Mare Island and ordered to report at Portsmouth navy yard. In Portsmouth navy yard, during the building of the "Marion," "Enterprise," and "Essex," the latter ship coming directly under the supervision of Mr. Hichborn, and the repairing of many other ships of the navy, an experience was gained that afterward bore abundant fruit. In July, 1875, after passing a competitive examination at New York navy yard, in which he distanced all his competitors, he received his commission as a naval constructor, mark No. 1. In December, 1875, he reported for duty at Philadelphia, and assisted very materially in straightening out the confusion incident to moving the tools, material, etc., from the "old yard" to the "new," then located at League Island. At this time he also superintended the rebuilding and fitting out of the old "Constitution," which was to carry goods to the Paris Exposition. By special invitation, he took an active part in the ceremonies of the Centennial Exposition held in Philadelphia the following year.

In 1880, when Congress awoke from its lethargy, determined to reorganize the navy and no longer be the "laughing stock" of the world, Naval Constructor Hichborn was selected by Secretary Hunt to serve as a member of the first Naval Advisory Board. In addition to this and his regular duties at the navy yard, he had in charge the superintendence of construction and completion of the monitors "Terror," "Amphitrite," and "Puritan," and it is due to him that two of these vessels were converted from double-turreted monitors of doubtful utility into double barbette-turreted coast defense vessels of a very formidable type. These highly efficient barbette-turrets, familiarly styled "Hichborn turrets," were unanimously approved by the Board of Bureau Chiefs, and have since been improved and perfected and become a part of the construction of every turreted vessel of the navy.

In 1884, the need of an expert to go abroad and investigate naval progress in Europe, resulted in the selection by Secretary Chandler of Naval Constructor Hichborn, his knowledge and experience eminently fitting him for that duty. How well he acquitted himself of this task, and the value of his report on European dockyards, is attested by the two editions Congress found necessary to authorize. On his return from Europe he was detached from duty at the navy yard, League Island, and ordered to the Navy Department, Washington, D. C., as Assistant Chief of the Bureau of Construction and Repair, and concurrently to the navy yard, Washington, as naval constructor at that station, in conjunction with duties at the navy yard and the Bureau of Construction and Repair. At all times prominently associated with all matters affecting the designing and construction of our naval vessels, he was while acting in these dual capacities also a member of several Boards, prominent among which were the Board of Inspection and Survey, and the Board on Life Boats. While a member of the latter Board, he gave especial attention to life-saving appliances, and a careful consideration of this subject resulted in the invention of the "Franklin Life Buoy," which was highly commended at the International Maritime Exhibition in Boston, by the International Maritime Conference in Washington, the World's Fair at Chicago, and has secured a medal from the Paris Exposition of 1900. This buoy has been in use in the United States navy for a number of years, and in the Russian, Japanese, German, French and English navies, as well as the merchant service. On the 12th of July, 1893, Naval Constructor Philip Hichborn was appointed by the President of the United States to the highest position within the gift of the Construction Corps of the Navy, that of chief constructor and chief of the Bureau of Construction and Repair, with the relative rank of commodore. He has been appointed twice to that office, and the eight years of his occupancy has resulted in great credit to the navy. He has been, for a number of years, a member of the Institute of Naval Architects, of England, and was a few years ago elected an honorary life member of the organization; of the Naval Institute of Annapolis, and one of the Vice-Presidents of the Society of Naval Architects and Marine Engineers of the United States since the organization of that society. The proper form and requirements for "Ship Boats" has occupied his attention for a number of years; in fact, this has been one of his successful "hobbies" ever since he was a shipwright. While at Mare Island navy yard he designed, built and sailed a boat that in a race of ten miles distanced all competitors, and won for him a silver tea set, valued at over $300. While at the navy yard, League Island, he designed a complete set of ship's boats, which were adopted as standard and built for all vessels of the navy. He has recently issued a book, under authority of the Department, entitled "Standard Boats of the U. S. Navy," for use in navy yards and stations, in which the general plans of each size of boat are shown in conjunction with photographs and details of same. No book embracing such minutiæ in such matter has ever been published in any navy.

After redesigning the "Puritan," he turned his attention to inclined or deflective armor, and to his strong and determined advocacy, the inclined front plate of turrets and the adoption of the present very efficient balanced turret is due. He has been responsible for the adoption of many modern improvements, notable among which are electrical appliances on shipboard, water-tube boilers, fireproof wood, submarine boats, and the change from 13-inch to 12-inch guns as the largest caliber gun to be used in the navy. His own inventive and practical genius has contributed many valuable improvements in ship fittings. His sole object has been to make the officer and sailor more comfortable and the ship more efficient. The elegant models of the ships of the navy, which have excited much admiration at home and abroad, have all been made under his direction.



THE BERGET PENDULUM.

T, pendulum rod; *P*, cylindrical bronze weight; *S*, wooden support; *C*, divided circle; *M*, micrometric microscope; *L*, projection apparatus; *R*, total reflection prism; *L*, lantern. The Cardan suspension is shown in the cartouche.

NEW APPARATUS FOR DEMONSTRATING THE REVOLUTION OF THE EARTH.

EVERY ONE has heard of the celebrated experiment performed by Leon Foucault at the Pantheon in 1851, and which gave for the first time a direct experimental demonstration of the revolution of the earth.

Foucault started from the principle that when a pendulum swings and is freely suspended from a point, the plane in which it moves is invariable. If the support that sustains it be made to turn, the plane of oscillation will remain fixed in space.

Now, every pendulum fixed to a stable support resting upon the ground has, by this very fact, a support that participates in the rotary motion of the earth. If, then, the latter revolves, the plane in which the pendulum swings will, since it is invariable, displace itself with respect to the earth and seem to turn in a direction opposite that of the rotary motion of the planet, through the same optical illusion that we observe when we happen to be in an immovable train alongside of one in motion. The experiment above mentioned was performed by Foucault by means of a pendulum formed of a wire 213 feet in length suspended from the cupola of the Pantheon and provided at its lower extremity with a very heavy lead bob. At every swing, a knife, fixed under the heavy bob, made an incision in two small heaps of sand; and the incisions thus made periodically were seen to shift from east to west with a constant velocity, such that there was deduced therefrom one entire revolution in 36 hours.

The Foucault experiment, although simple in appearance, is difficult, if not impossible to perform unless we have at our disposal a hall at least 35 or 40 feet in height; so up to the present it has been one of those celebrated experiments that every one has heard of but no one has ever witnessed.

M. Alphonse Berget, doctor of sciences, has succeeded in repeating this fundamental experiment in a simple manner, not with the dome of the Pantheon as a support, but with a simple pendulum only a little over three feet in length. To this effect, he does not employ a wire pendulum, but one formed of a rigid bronze rod sustaining a brass cylinder weighing about four and a half pounds.

The apparatus is supported by a Cardan suspension formed of two steel knife edges carried by two rings and placed at right angles. Under such circumstances, if the prolongations of the two knife edges that meet each other are upon the axis of the bronze rod, the pendulum will oscillate freely around a geometrical point and lend itself to an exact carrying out of the Foucault experiment.

In an inoperative position, the vertical rod hangs in the center of a divided circle provided with an alidade upon which is a microscope of which the optical axis is a radius of the circle. This alidade carries a vernier with an adjusting screw that permits of measuring small angles with precision.

The pendulum is moved from its position of equilibrium by means of a thread that connects it with a rod fixed upon the axis of the microscope. A very fine style that terminates the bronze rod having been set, the thread is burned. Then the pendulum swings, and at each extreme position of its oscillation its image is in focus in the field of the microscope. This field is traversed by a reticule, and if, at the beginning, the image of the oscillating style has been made to coincide with the vertical rod, it will be seen that the coincidence ceases in the direction indicated by theory with the second oscillation. If, at the end of six minutes, the coincidence be re-established, it will be found that the microscope has been displaced by one degree upon the circle. This is exactly the angle indicated by astronomy.

The experiment, performed at the Academy of Sciences, was repeated by M. Berget at the Paris Observatory with great success before the members of the Congress of the Celestial Map. It was repeated a few days afterward in the great amphitheater of physics of the Sorbonne before the members of the Congress of Physics, who saluted this remarkable demonstration with long-continued and enthusiastic applause.

The accompanying figure, from La Nature, represents the apparatus as it was arranged at the observatory. The experiment was projected by means of the electric light.

The mechanical part of the apparatus was constructed by the MM. Château and the optical by M. Pellin.

CARBIDE OF THE NEW METAL SAMARIUM.*

THE samarium oxide, Sa_2O_3, white in color, used in my experiments in producing the carbide of samarium, was furnished partly by M. Demarçay and partly by Messrs. Chenal and Donilhet, who are entitled to my cordial thanks.

Preparation of Samarium Carbide.—A mixture of 200 grammes of samarium oxide and 20 grammes of burnt sugar, reduced to fine powder, was agglomerated by pressure. The apparatus described in previous experiments was used, and after four minutes of heating by the electric furnace, with a current of 900 amperes under a force of 45 volts, a mass of melted carbide of 150 grammes was obtained.

Properties.—The carbide possesses greater metallic luster than the carbides of neodyme and praseodyme. Small fragments, examined by the microscope, were of yellow color and transparent. Some parcels presented very distinct hexagonal fragments. Its density is 5.86.

It is irreducible by hydrogen at 1,000 degrees. Slightly heated, it becomes incandescent in a current of fluorine or of chlorine, producing corresponding compounds. Bromine and iodine attack it at about the dark red.

In a current of oxygen at about 400 degrees, it is completely burned, provided the fragments are sufficiently small, leaving an oxide of yellowish white. Sulphur also attacks it, but at a much higher temperature.

This carbide is decomposed by cold water, like the carbides of the same group, which I have already described. It is then converted into liquid and solid carbides and a gaseous disengagement, which yields to analysis the following figures:

	1	2
Acetylene	70.1	71.2
Ethylenic carbides..................	7.6	8.1
Hydrogen and formenic compounds.	22.3	20.7

The hydrogen carbides, disengaged by samarium carbide, on contact with water, are very similar in composition to the gases furnished by yttrium carbide. The last produces 71.7 to 71.8 per cent of acetylene, while cerium carbide yields 78.47 to 80 per cent.

The acids, such as boiling sulphuric acid, are reduced by the carbide of samarium. When these acids contain water, the violence of the reaction is in the proportion of the quantity of water.

Hydrogen sulphide attacks it at the red without incandescence and with formation of sulphur.

Chlorhydric acid gas reacts on this carbide at the dark red; the incandescence is very brilliant. The resulting black product occupies, after the reaction, a volume much greater than the original carbide. Thrown into cold water, a colorless solution results, and a precipitate of oxide without gaseous disengagement.

Analysis.—The analysis of samarium carbide is conducted by same process as that of the carbides of

* Paper presented by H. Moissan to the Académie des Sciences.

neodyme and praseodyme. It yields the following results:*

Percentage.	1	2	3	4	Theory for SaC_2.
Samarium	85.80	85.90	85.98	86.65	86.20
Carbon	13.50	13.46	13.46	13.46	13.79

Conclusions.—Samarium oxide furnishes readily in presence of carbon, and at the temperature of the electric furnace, a crystallized carbide of the formula SaC_2, of which the composition corresponds to that of the carbides of cerium, lanthanum, neodyme and praseodyme. This carbide decomposes cold water, like the alkaline earthy carbides, yielding a complex mixture of hydro-carbons very rich in acetylene.

The decomposition of samarium carbide by water resembles that of the metal yttrium and separates it from the cerium group of rare earths.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

A German View of American Prosperity.—Under the striking title of "The American Danger," the Hamburger Fremdenblatt of December 8 presents on its front page an editorial article, based upon the annual report of the Secretary of the United States Treasury, which is herewith translated as follows:

The statement in the annual report of the finance minister of the United States that the national revenues have increased by $58,500,000 and the expenditures decreased by $117,000,000 merits serious attention. The United States had only a few years ago to struggle with not inconsiderable annual deficits in the national revenues; it has regularly sent abroad—principally to England and Germany—a large part of the interest on national bonds and a considerable share of railway and industrial securities, and has had to make for more than ten years past a yearly appropriation for the pensioners of the war of the rebellion larger than the cost of the German army and navy. The Union has had to meet more recently the heavy cost of the war with Spain, and its industries have to reckon with considerably higher wages and higher rates of interest than the European countries. In spite of all this, the national budget of the United States shows the favorable balance which is announced in the annual report of the Treasury. The reasons for this are made plain by the report itself, from which may be learned much more that is timely and valuable.

We see, for example, from the table of exports and imports that the United States exported during the last (fiscal) year goods valued at $1,394,483,682, of which more than $1,370,000,000 was of domestic origin. In these gigantic figures—one must compare them with the export statistics of European countries to realize their full significance—the item of manufactured goods amounted to 31.54 per cent; that is, nearly a full third of the whole export. To appreciate this fact, it must be remembered that in the year 1898 only 28 per cent, in 1895 only 23 per cent, and in the year 1890 only 17 per cent of the total exports were the products of manufacturing industries. These figures mean more than they alone say. They speak a threatening language; they say clearly and forcibly that the United States, which ten years ago exported more than 80 per cent of agricultural products and less than a fifth of manufactured goods, to-day draws nearly a third—more than 14 per cent more—of its entire export from the products of its factories. In other words, the Union is marching with gigantic strides toward conversion from an agricultural to an industrial nation.

This will be more apparent if we consider the export statistics of the years 1899 and 1900 from another standpoint. We see that the value of industrial products exported during the fiscal year 1899 was $339,592,146, while that of the fiscal year 1900 was $432,284,366, an increase of a round $100,000,000, or 27 per cent, in a single year. Do not such an enormous increase and the correspondingly rapid progress in productive and selling capacity constitute an imminent danger for all competing nations?

Similarly interesting is also the influence of this development of export trade. The Union came out of the civil war during the early sixties with one of the heaviest national debts recorded in history. This debt was for the most part paid far earlier than the world, or even the Americans, expected, and it was paid mainly by the export of agricultural products. When, about twenty years ago, the industries of the United States began to revive, and under the protection of exorbitant duties developed and strengthened, they suffered in all branches—often seriously—for want of domestic capital. The great transcontinental railways were built partly—in some cases, principally—with foreign—principally English and German—money, and similarly different great industries were obliged to draw capital directly or indirectly from Europe to extend and increase their facilities. The natural result of these conditions was that Europe held a large share of the railway and industrial securities on which the Union had to pay interest abroad, and, since this interest was payable in gold, there was a strong and constant outflow of the yellow metal, to the injury of the financial situation at home. From this it resulted that during many years the imports from Europe reached higher figures than the exports from the United States, and the resulting adverse balance had to be paid to Europe—likewise in gold. This was the cause of the constant scarcity of money, especially gold, which during the later eighties and the early nineties, in connection with the then unstable financial politics of the government, repeatedly brought the gold reserve below the legal limit for the protection of the currency and necessitated at that time a new loan and new gold imports and an increase of interest to be paid to Europe. Things went so far that the United States became financially wholly dependent upon Europe, and the rate of interest was practically dictated from London.

From the beginning of the past decade, a series of different factors caused a decided change in this situation. Several unusually good harvests succeeded each other, and two of these, coming in conjunction with bad crops in Russia, changed the balance of trade in favor of the United States and brought a corresponding flow of money to America, instead of from that country to Europe. Numerous industries, among which were many gigantic undertakings, were in part newly established, partly enlarged through the assistance of the protective tariff on their products. These found, in consequence of the rich harvests and the active building of railways and new industries, an eager market at home and an increased demand abroad. These industries were promoted not only by such favorable conditions, but still more through practical and highly improved processes and the use of labor-saving machinery; as a result of which they were soon able to emancipate themselves wholly from foreign capital and through the strengthening of domestic financial conditions to reduce the rate of interest to a normal figure. As soon as the American industries thus got upon their own footing and were in a position to support the railroads, which were strengthened by increased freights and the gigantic harvests, and were thus brought into a greatly improved financial condition, they likewise undertook the task of freeing themselves from foreign capital; in other words, of reclaiming the industrial securities which were in European hands; and then, sustained by the protective tariff against foreign competition, they began to dominate foreign markets—first, those of Central and South America, Asia, and Africa, and finally those of Europe. The change in the condition of the United States can best be characterized by the statement that the industries, trade, agriculture, railroads, and finances of the Union each and all climbed, one upon another, through and by each other, steadily upward. And to what a height have they climbed!

The United States, in the year 1899, mined 3,437,210 ounces of gold, valued at $71,053,400, and silver with a bullion value of $32,858,700 and a coinage value of $70,806,626. That raised the specie supply of the Union to $1,034,439,264 in gold and $647,371,630 in silver. Since the total gold and silver coinage of the world during the calendar year 1899 was $466,110,614 in gold and $166,226,964 in silver, and the total money supply of the world on the 1st of January, 1900, was $8,659,900,000 in coin and $2,960,100,000 in paper currency, the United States finds itself in possession of one-fifth of the entire gold and silver money of the civilized world.

If we now turn to an investigation of all the elements which have produced this tremendous, this almost incredible, revolution in the world's situation, it is impossible within our present limits to consider all the factors which are of importance to German interests as well as essential to a comprehensive conclusion. Competent experts, well informed as to the industrial and export conditions which prevail in the United States, have established the following facts:

The steel manufactories of the United States, which two decades ago were in their infancy, to-day control the markets of the world, dictate either directly or indirectly the prices of iron and steel in all countries, and, partly through the richness of their supply of iron ores and coal, partly by the use of labor-saving machinery and skillful, effective means of transportation, have attained a position to not only compete with the older iron-and-steel producing countries, but even to profitably export their products to England.

American tools, especially hatchets, axes, files, saws, boring implements, etc., enjoy by reason of their excellent quality the best reputation, and, in spite of their higher price, stand above competition in nearly the whole world. Also in sewing machines, bicycles, and agricultural implements of every kind, the United States has begun to drive England and Germany from the world's markets, especially that of Russia, which may be partly attributed to the fact that American firms are protected in their own market from foreign competition and can thus sell their manufactures cheaper abroad than at home.

A remarkable change has also taken place in the field of boot and shoe production. Hardly more than ten years ago the United States imported shoes from Europe, especially women's foot wear from Austria, while other grades were made of leather imported from England and Germany. To-day it not only makes its entire supply of leather at home and exports it in considerable quantities, but it floods Europe with ready-made shoes, competes with the products of cheap labor in England, establishes shoe depots in Paris and even in the principal cities of Germany.

That the United States, by reason of its richness in mineral oils and aided by its unrivaled facilities for refining and transporting this international necessity, controls the petroleum trade of the world and is held in check only by Russia is well known, and the fact is only cited here in order to include this weighty factor in the calculation. The experience of the past few months proves that within a not far distant period the coal of the United States will play the same rôle in the markets of the world. The Union has reversed the old adage, "It is ridiculous to carry coals to Newcastle," for to-day anthracite coals from Pennsylvania are actually exported to England.

Incidentally, it may be remarked that the typewriting machine with which this article is written, as well as the thousands—nay, hundreds of thousands—of others that are in use throughout the world, were made in America; that it stands on an American table, in an office furnished with American desks, bookcases, and chairs, which cannot be made in Europe of equal quality, so practical and convenient, for a similar price. The list of such articles, apparently unimportant in themselves, but in their aggregate number and value of the highest significance, could be extended indefinitely. But it would seem more interesting and characteristic to cite the fact that an American syndicate is now planning, and has even taken the initial steps in a scheme, to take in hand the whole sleeping-car service of Europe, to improve it and make it cheaper than is now possible. Moreover, American manufacturers of underclothing, gloves, and men's clothing, as well as women's cloaks—all articles which a few years ago were exported in vast quantities from Europe to the United States—are already beginning to calculate how they can place their surplus output in European markets.

But enough of examples. Every one who understands the existing conditions and has followed these conclusions, drawn from the best sources and based upon thorough knowledge of the facts, will agree that the threatened danger from America is neither exaggerated nor painted too darkly, but is, in fact, real and serious. But the mere recognition of the peril avails nothing; what is demanded is to face it, to overcome it, or at least to minimize as far as possible its effects. We must ask ourselves whether this is still possible, and, if so, what are the means, the methods, that must be employed to secure a successful result. There is but one answer to this question. We must fight Americanism with its own methods; the battle must be fought with their weapons, and wherever possible their weapons must be bettered and improved by us. Or, to speak with other and more practical words, Germany—Europe—must adopt improved and progressive methods in every department of industry; must use more, and more effective, machinery. Manufacturers as well as merchants must go to America, send thither their assistants and workingmen, not merely to superficially observe the methods there employed, but to study them thoroughly, to adopt them, and wherever possible to improve upon them, just as the Americans have done and are still doing in Europe.—Frank H. Mason, Consul-General at Berlin.

Proposed Electric Railway for Leicester.—The tramways subcommittee of the Leicester corporation has issued a lengthy report upon its investigation of the different systems of tramway traction in operation in various cities and towns of Great Britain, together with a number of important recommendations. The committee has come to the conclusion that the overhead trolley system of electric traction is the most efficient, reliable, quick and economical system extant, and therefore recommends its adoption in Leicester, following the purchase of the present tramway company's undertaking. The scheme which is outlined in the committee's report involves the reconstruction of existing tramway lines and their extension to various points on the outskirts of the borough. It also recommends the adoption of the continuous direct-current system of generating plant, with a central power station situated on land already belonging to the corporation. If the scheme should be approved by the town council, parliamentary powers will be sought for carrying out the various works involved, which will include the laying of eighteen miles of double lines in the borough. The report will be brought before the council for consideration at an early date.—S. C. McFarland, Consul at Nottingham.

Traffic in the Suez Canal in 1899.—It appears from the last annual report of the board of managers of the Suez Canal Company that there was a substantial increase in the traffic of the canal during 1899, as compared with the year previous, especially in the total tonnage of vessels. In 1898, the number of vessels that passed through the canal was 3,503, with an aggregate burden of 9,238,603 tons, whereas in 1899 the number was 3,607 vessels, representing an aggregate burden of 9,895,630 tons. This is a gain of 104 vessels and 657,017 tons. The average burden of vessels increased from 2,637 tons to 2,743 tons.

The average time consumed in passing through the canal during the year 1899 was eighteen hours and thirty-eight minutes, an increase of thirty-eight minutes as compared with 1898. This increase is accounted for by the fact that vessels passing through the canal under quarantine are compelled to avoid any contact with the land, and must stop at night if not provided with electric headlights. However, the time actually consumed by vessels in steaming through the canal was less in 1899 than the year previous, having been reduced from fifteen hours and forty-three minutes to fifteen hours and forty-one minutes. Last year 3,273 vessels, being provided with electric lights, were able to pass through the canal at night. These vessels formed 90 per cent of the whole number, against 94 per cent in 1898.

It is worthy of note that only 327 steamers passed through the canal for the first time.—Frederick W. Hossfeld, Consul at Trieste.

Belgian Demand for Poultry-Plucking Machine.—Consul Le Bert reports from Ghent, January 15, 1901, that he has received a request from M. Dutry-Colson, No. 12 rue des Champs, Ghent, for names and addresses of manufacturers of poultry-plucking machines. This is an old-established firm, adds the consul, and one of the largest general hardware houses in Belgium. Early replies are much desired.

Development of Samoa.—Consular Agent Harris sends the following from Eibenstock, January 5, 1901:

German plantation experts claim that the Samoan Islands have a great future in coffee, tea, tobacco, cotton, etc. Upolu Island, it seems, is especially suitable for the culture of all these products, possessing, as it does, favorable position, a fruitful soil, and a good climate. A company is at present being formed in Germany for the purpose of exploiting this island—laying out plantations, establishing narrow-gage railways, etc. Men of practical experience, who acquired their knowledge of plantations in East Africa and Brazil, are at the head of the enterprise. Work is expected to commence next spring.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

* The atomic weight of samarium has been taken as 150.

TRADE NOTES AND RECEIPTS.

Coating for Aluminium.—Dissolve 100 parts of gum lac in 300 parts of ammonia, and heat the solution for about 1 hour moderately in the water bath. After cooling, the mixture is ready for use. The aluminium to be coated is cleaned in the customary manner. After it has been painted with the varnish, it is heated in the oven to about 300 deg. C. The coating and heating may be repeated.—Lack- und Farben Industrie.

Receipts for Polishes.—Polishes Containing Wax.—a. 15 parts of oil of turpentine, dyed with anchusine, or undyed, and 4 parts of scraped yellow wax are stirred into a uniform mass by heating on the water bath.

b. Melt 1 part of white wax on the water bath, and add 8 parts of petroleum. The mixture is applied hot. The petroleum evaporates and leaves behind a thin layer of wax, which is subsequently rubbed out lightly with a dry cloth rag.

Varnish-like Polishes.—a. Dissolve 15 grammes of shellac and 15 grammes of sandarac in 180 grammes of spirit of wine. Of this liquid put some on a ball of cloth waste and cover same with white linen moistened with raw linseed oil. The wood to be polished is rubbed with this by the well-known circular motion. When the wood has absorbed sufficient polish, a little spirit of wine is still added to the polish, and the rubbing is continued. The polished articles are said to sustain no damage by water, nor show spots or cracks. b. Orange shellac, 3 parts; sandarac, 1 part, dissolved in 30 parts of alcohol. For mahogany, add a little dragon's blood.—Leipziger Drogisten Zeitung.

Bleaching of Linseed Oil and Poppyseed Oil.—In order to bleach linseed oil and poppyseed oil for painting purposes, thoroughly shake 2.5 kilos. of it in a glass balloon with a solution of potassium permanganate 50 grammes in 1.25 kilos. of water; let stand for 24 hours in a warm temperature, and then mix with 75 grammes of pulverized sodium sulphite. Now shake until the latter has dissolved and add 0.1 kilo. of crude hydrochloric acid, 20 degrees. Agitate frequently and wash, after the previously brown mass has become light-colored, with water, in which a little chalk has been finely distributed, until the water is neutral. Finally filter over calcined Glauber's salt.—Seifensieder Zeitung, Augsburg.

Process of Manufacture of Boracic Acid and Ammonia by the Action of Ammoniacal Chlorhydrate on Native Borates.—The firm of Chenal, Donilhet & Co. assure us that by this process, which is their own, they obtain 98 or 99 per cent of the acid contained in the borate, by preventing the stoppage of the decomposition.

They operate with ammoniacal chlorhydrate in solution with the borates, but instead of allowing the action to pursue its own course, they take out portions of the liquor during the operation and cool them for the purpose of separating the boric acid by crystallization, sending back the mother waters to the borate. Thus there is never in the liquor in ebullition sufficient boracic acid for reaching the critical point and causing an opposite reaction. The principal reaction is, therefore, continued without interruption, and in full activity, to the complete decomposition of the borates.

It is well to calcine the natural borates before they are used, which facilitates the reaction.—Translated from La Revue des Produits Chimiques.

Improvement in the Manufacture of Sulphuric Acid. By M. Potut.—In the present arrangements for the manufacture of sulphuric acid, the sulphurous gas proceeding from the roasting furnaces of the pyrites is brought into the Glover tower, where it passes from below upward through interstices between pieces of inert matter (Volvic lava,* quartz, basalt, etc.) sprinkled with nitric acid.

Besides the expense of so large a consumption of the acid, there is the disadvantage of the escape of a part of the sulphurous gas, because the acid (whether the sprinkling is intermittent or continuous) does not uniformly permeate the whole mass of inert matter.

This consideration has led the author to the following improvement, which consists in causing the reaction of the two bodies on each other, not by the circulation of the sulphurous gas in contact with the liquid nitric acid, but by the intimate mixture and stirring, at a high temperature, of the gas with the nitric acid sprayed finely by a jet of steam.

Although the author has prepared a special apparatus, the spraying of the acid can be effected by any of the contrivances employed in various industries for the spraying of liquids by an injection of steam or compressed gas.—Translated from La Revue des Produits Chimiques.

Improvement in the Preparation of Chlorine, Designed for Use in the Extraction of Metals from Their Concentrated Ores, Waste, Sediment, etc. By M. Sturge.—The ore or matter to be treated, prepared by roasting or otherwise, is put, ground or broken, into a solution of alum, aluminium sulphate, or some other sulphate or persulphate, to which is added a solution of calcium hypochlorite (chloride of lime). Chlorine is disengaged, which, in a nascent state, is extremely active in uniting with gold and other metals, forming soluble chlorides.

When aluminium sulphate is used with calcium chlorine all the chlorine is disengaged.

If alum is employed, potassium sulphate is produced, and all the chlorine in the hyposulphite is also liberated.

The strength of the solution and the time necessary for lixiviation depend on the matter treated. A typical proportion consists of 20 kilos of aluminium sulphate and 20 kilos of calcium chloride, mixed with a ton of waste, sediment, etc., mingled with a sufficient quantity of water.

The operation can be conducted in an open or closed vessel, a cylinder or barrel, which can be rotated. The liquid containing the metal is afterward treated according to the method now in use.—Translated from La Revue des Produits Chimiques.

* The Volvic lava is used extensively in Paris, especially for pavements. It receives its name from the village of Volvic, where there are large quarries. It is the principal building material for that and neighboring villages.—Trans.

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